AVIATION

CONTENTS FOR NOVEMBER, 1945

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Briefing for November 5

Down the Years in Aviation's Log 5

Editorial: They Must Remember Hiroshima 105

Know Your Operating Costs ..... *Neil M. Berboth* 106

Aviation Marketing

Sell Airplanes Over the Counter 110

Aviation Finance

With Ready Money Mounting, It's "Cash and Carry On" ..... *Raymond L. Hoadley* 112

Aviation Research—Engineering—Production

Design Analysis of the Messerschmitt Me-262, II ..... *John Foster, Jr.* 115

Analyzing the Aspects of Future Flight, I ..... *C. E. Pappas and M. G. Harrison* 131

Layout Reproduction the Loftec Way 135

Designing Tomorrow's Personal Airplane, VI ..... *Ralph H. Upson* 136

Landing Analysis for Flying Boats and Seaplanes, II ..... *Ernest G. Stout* 140

Stretch Forming Plus Impact Banishes Joggling Problems ..... *Douglas Hodges* 147

New Type Flaps Lower C-74 Landing Speed 150

These Special Fixtures Speed Engine Mount Output ..... *Harry Merle* 152

For Better Design: Torsion-Element Spring Tab Combines High-and-Low Load Efficiency 154

Plant Practice Highlights 157

Aviation's Sketchbook of Design Detail 195

Aviation's Engineering Data Book 203

Review of Patents ..... *A. Harry Crowell* 204

New Products and Practices 229

Aviation Maintenance

This Double-Duty Scoresby Saves Time and Space 159

Correct Servicing Determines De-Icer Efficiency, II 162

Aviation's Maintenance Notebook 165

Flying Equipment

Jet and Conventional Engines Combined in Ryan FR-1 Fireball 171

Martin 202 and 208 Planned as New Short Haulers 172

AA Choosing Feederliner With Aid of Employee Poll 173

DH Vampire and Hornet Which Were Set to Jab Japs 174

Ensign Two-Placer Features Bubble Canopy 175

Boeing Stratocruiser Aimed at Low-Cost Operation 176

Military

Nazis Brinked the Fantastic in Drive to Re-Command Air 180

Civil Operations

How Slanting for Satisfaction Boosted Airport Business ..... *Edward E. Thorp* 184

Tagging the Bases 186

Air Transport

Airport Planning Must Gather Impetus ..... *Erwin J. Bulban* 189

Globe Calculator Is Quick on Avigation Data 193

Recent Books 204

Side Slips 227

The Aviation News

National Aviation 207

Coming Up 207

Washington Windsock 211

Aviation Manufacturing 213

Transport Aviation 217

Aviation Abroad 221

Financial Notes 222

Aviation People 225

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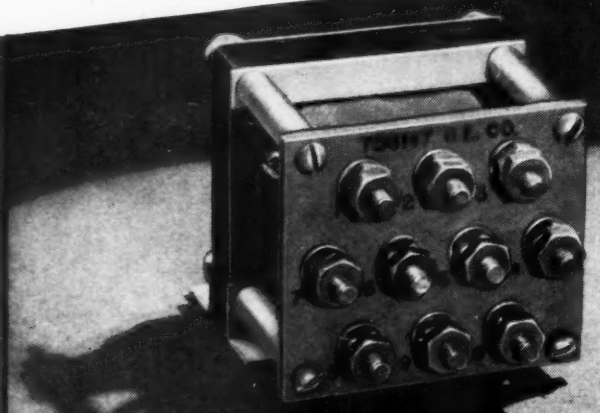
A NEW, MORE EFFICIENT WAY to operate and control 6-volt instrument lights



The G-E 400-cycle, single-phase aircraft transformer

Output: 30 va at 6 volts
Lightweight: 1 pound
Small: 2 1/4 by 2 5/32 by 3 3/16 inches

● This lightweight, compact transformer provides an efficient method of operating 6-volt aircraft instrument lamps, such as the MAZDA 328 midget. Its output capacity allows the simultaneous operation of 25 such lamps at full brilliancy. Two types are available: one with taps and one without.

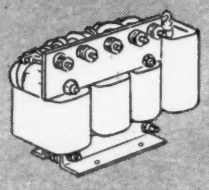
The secondary voltages of the unit with taps are: 6, 4.8, 3.94, 3.27, 2.78, 2.27, and 1.74. Each voltage reduction approximately halves the previous candlepower output of the lamps. Thus a preselection of light level is possible —ranging from a very low candlepower to full lamp brilliancy.

The unit not provided with taps has a 6-volt secondary. Any desired light level can be maintained (within the transformer's rating) by using a potentiometer to vary the transformer voltage smoothly.

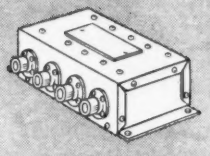
These new transformers are designed to resist moisture, heat, vibration, shock, and corrosion. They will operate successfully at any altitude, if sufficient ventilation is provided.

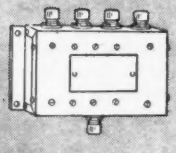
For further information ask for Bulletin GEA-4412. Or, for data on our complete line of aircraft transformers, write for Catalog GEA-4238. *General Electric Co., Schenectady 5, N. Y.*

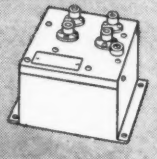
IMPROVE AIRCRAFT ELECTRIC SYSTEMS WITH THESE G-E TRANSFORMERS



3 to 1-phase, 2 to 3-phase, and 1 to 3-phase transformers







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BRIEFING

Getting over the hump of compressibility and into the truly supersonic speed range presents plenty of tough, but certainly not insurmountable, odds. In fact, the time when it will be accomplished isn't as far away as many think. As a boost toward getting over that hump we're more than a little proud to present "Analyzing the Aspects of Future Flight" (page 131) by "Gus" Pappas and M. G. Harrison, who are Republic Aviation's Chief Aerodynamicist and Mathematics Consultant, respectively. It's a thoroughgoing analysis of the types of airfoils that will be needed; the powers required; and what must be done to whip friction and extremely high altitude heat problems.

As promised last month, AVIATION presents the first complete design analysis ever published on a jet engine. Beginning on page 115, this study not only reveals the principles and complete workings of the axial flow type JP unit, but it also shows what the Germans had to overcome in the way of materials and labor as they developed the Junkers Jumo 004 plant, which powered the Me-262 and which was slated to go in several other jobs they weren't able to get into combat.

Rounding out our Research—Engineering—Production Section are some mighty interesting details of particular interest to the men who have to build the planes. On page 147, for example, Douglas Hodges of Douglas' Long Beach plant gives the "inside" on how "Stretch-Forming Plus Impact Banishes Joggling Problems."

Rare indeed is the manufacturer, distributor, or personal plane owner who can tell you exactly what the operating costs are on any given plane. Just why this should be so is something of a mystery, but it's true, nevertheless. However, it needn't be a mystery any longer, for Neil Berboth of Fairchild's Development Div. has worked out a simple formula (you don't have to be an Einstein to use it) which can be applied to any airplane, from the design stage on through any given period of utilization. In short, the methods presented in "Know Your Operating Costs" (page 106) can be used right across the board—by aircraft producers, their distributors, and by the ultimate owners.

On another phase of this producing and distributing business, there've been a lot of questions raised with the recent entry of department stores in the sales field. Many people are as confused as our old friend Maguire (page 227)—they want to know if the sock and lingerie boys are really going to sell planes; they want to know what effect the new setups may have on the keystone of distribution, the fixed base operator. Just how the pattern is shaping up is given on page 110.

AVIATION's "Pete" Bulban puzzles over instrument panel of Germany's Flettner FL-282 helicopter during his visit to ATSC's Freeman Field, where correspondents recently had a chance to study a wealth of captured enemy equipment. Some of craft Jerries had under development, he reports, were mighty close to fantastic. It's easy to believe when you read his story, which starts on page 180. (H. G. Martin photo)

Down The Years In AVIATION'S Log

25 Yr. Ago (1920) — Aeromarine-West Indies Airways starts first U. S.-Havana airline, using converted Navy F-5-L flying boats. . . . Belgian Lt. Ernest Demuyter wins Gordon Bennett International Ballon Race, traveling 1,100 mi. . . . N. Y. C. Aerial Police Reserve organized to regulate air traffic and combat possible river pirates. . . . Laura Bromwell, Girl Scout aviation instructor, predicts that "in 1940 flying will be as simple a mode of travel as the automobile—and much safer". . . . Los Angeles-San Diego Airway company started, using Mercury all-metal planes. . . . Jap Navy secures services of 30 British flyers as instructors. . . . Polish army bids for American planes and pilot services. . . . Canada plans trans-Dominion flight contest with $7,000 prize.

15 Yr. Ago (1930)—Total of licensed airplanes in U. S. is 2,696. . . . Airlines report average revenue of $0.84 per plane mile. . . . SAE reports experiments showing improved power and economy through use of higher octane fuel. . . . PAA increases South American route mileage from 216 to 19,190 in year. . . . Of 1,764 U. S. airports, 513 are municipal. . . . Total airline route mileage in Latin America is 41,294. . . . Navy experiments with magnesium propeller blades. . . . Yacht *Lotosland,* owned by Col. E. A. Deeds, carries Sikorsky S-39 amphibian.

10 Yr. Ago (1935)—PAA announces purchase of Martin 130 China Clipper 48-passenger flying boat with 18 berths, for Orient service. . . . First Air Navigation Week proclaimed. . . . USSR drops 500 paratroopers in experimental maneuvers. . . . Eastern buys five Lockheed Electras. . . . Phillips Petroleum Co. purchases twin-engine Boeing 247-D for flying office. . . .French Liore et Olivier twin-engine bomber with 82-ft. span flies at 200 mph. . . . Dutch aviation firm reports cost of flying at $22.32 per hour, with total plane life of 1,500 hr. . . . Total of 23,000 student permits granted in first 10 mo. of year. . . . Benjamin King of Washington, D.C., flies to 15,082 ft. in Aeronca C-3, topping lightplane record by 3,727 ft.

"SUCCESSFUL PICK-UP OPERATIONS," states All American Aviation Corporation, "frequently mean flying at altitude and visibility minimums which actually represent instrument conditions. Minimum interruption of service plays an important part in Pick-Up operations as well as other types of airline operations." . . . Building a record of 92% completed schedules through some of the most treacherous flying country in the United States, blazing the trail for other Pick-Up operations, All American Aviation has relied many times on the complete high quality instrumentation of their Pick-Up planes to bring pilot, cargo and ship through safely. Kollsman accuracy and dependability can be one of your greatest assets, too. Be sure to write for the Kollsman Aircraft Instruments catalog. It is packed with facts and specifications to help you select the instruments to provide safe, all-around-the-calendar flight. Address: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, New York.

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EDITORIAL

They Must Remember Hiroshima

IN THE COURSE of recent hearings conducted by a Congressional appropriations committee, the chief of one of the important branches of our military aviation services was reminded that the United States was a "bankrupt nation". Whether or not the Congressman was right is for the economists to decide. But one thing is clear—the gentleman from Capitol Hill had forgotten Hiroshima.

It might not be too serious if only a single Congressman had forgotten about the war and about the manner of its ending, but there is cause for genuine alarm in the eagerness of the American people to lay aside their weapons and to depend wholly upon statesmanship to settle the differences that always will arise among nations.

The difficulty arises from the fact that the human mind finds it almost impossible to comprehend the tempo of technological development and the magnitude of the forces mankind now commands. We cannot turn the clock back to the days when wars were fought with bows and arrows. And we cannot go backward even to the time when we depended upon our brother nations to hold off the enemy until we were ready to meet him.

Appraisal of the technological achievements of our enemies makes one shudder. In many areas of endeavor the Germans were well ahead. As you look over the long list of their accomplishments you find example after example of highly perfected weapons misused through the sheer stupidity of one-man government. The fact that we *do* have and *can* have the most effective weapons in the world doesn't mean we always *will* have them.

IT IS EASY TO UNDERSTAND the attitude of some Congressmen and many taxpayers. We have airplanes and aviation equipment running out of our ears. But what most people do not understand is that almost all of it is hopelessly obsolete in terms of onrushing technical developments. If we pause even for an instant we will lose our leadership. At the moment we are so far ahead that we could impose our will upon the entire world, but this we do not choose to do. Since we are committed to this commendable course of nonimposition, we have no choice but to keep so far ahead in our technology that our strength continues to be respected. Weapons cannot be outlawed by weaklings.

It is true that poison gas was outlawed successfully during the recent war. But it was not by common consent of the participants. It was because of the simple fact that we had more of it than our enemies possessed, that ours was more deadly and was available in strategic locations. Our enemies knew and feared the achievements of our Chemical Warfare Service. It would be naive to assume that Germany and Japan refrained from using gas because it was outlawed.

Now we have created a weapon even more deadly than gas, and this weapon marks but a beginning of a new chapter in the affairs of men. To extend the range and effectiveness of that new weapon and to support its use in warfare, we must employ aircraft. But these may not be the same type used to carry it in the recent war. Atomic bombs can be carried in much smaller craft, even in those without crews. But larger aircraft will be needed for many missions, as well as to carry, ready for launching, the uninhabited aircraft that carry the atomic bombs, also to service the bases from which the uninhabited aircraft operate, and for many other purposes. Tactical uses will change the composition of future air forces, but all types of aircraft will be needed. Only the proportions of each type will change.

AND SO, if we desire to avert complete destruction we must be willing to foot the bill for continuous research, development, pilot line production, and tactical utilization of all types of weapons. No degree of relative bankruptcy must prevent us from preserving our government and industry research and development organizations. Plant capacity to retain sufficient manufacturing know-how, capable of instant expansion, must be maintained. And the wherewithal for continuous tactical development and evaluation must be provided for our armed services.

The suggested cuts in aircraft appropriations submitted to Congress by the President are much too drastic to keep the industry alive and effective as an important factor in our national security. Unless we face that fact now and raise our sights, we will return to our prewar position as a third or fourth rate nation in aviation.

If the cost seems like a high insurance premium to pay for our continued secure existence, we should remember that our nation also needs full employment. It is far better to give our citizens the jobs they will demand under a system of free enterprise than to let them rake leaves at the taxpayers' expense.

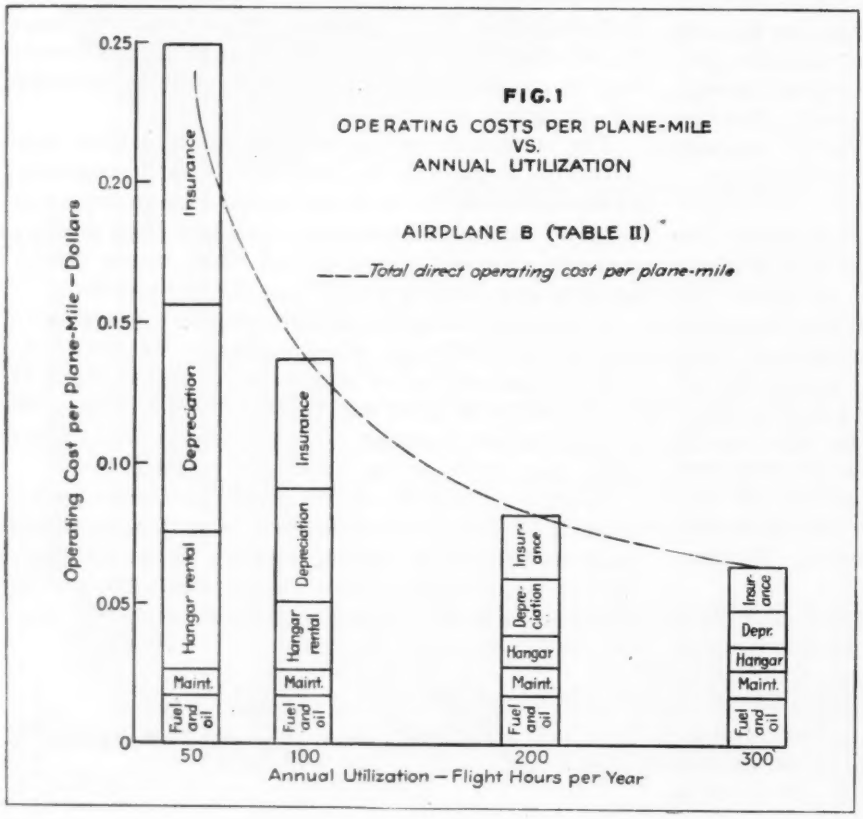
When our Congress and the people scan future appropriation bills they must bear these facts in mind. They must heed the stern warning sounded in General Marshall's recent report. They must evaluate the cost in terms of self preservation and national prosperity. And they must remember Hiroshima.

Leslie E. Neville

EDITOR

By **NEIL M. BERBOTH,** *Development Div., Fairchild Engine & Airplane Co.*

With this guide, manufacturers and distributors, as well as individual owners, may determine accurately the operating expenses of any craft over any given period of utilization.



VERY FEW, if any, plane owners or potential owners know the actual cost of owning and operating a personal plane. But they do know that it's high—too high. Generalities regarding cost factors are kicked around every day in the shop, drafting room, office, on the flight line, and in the cockpit. Pretty soon someone wonders why nobody ever thought up a simple way of calculating the detailed operating costs of any given airplane. Someone else mutters something about "variables", then everyone starts talking about the weather. But the subject shouldn't be dropped so readily.

That little item of expense, in relation to utility, will pretty much determine the amount of personal flying that will be done. An understanding of the elements that comprise operating costs should make for the designing of better and cheaper airplanes, help the salesman present the airplane to the potential buyer more intelligently and, finally, help the customer select his craft.

A precise method of calculating operating costs for light aircraft is needed—a method that will reduce the many variables to simple factors which will enable the determination of costs under all possible circumstances. A suggested method has been developed which, while presented as an equation for determining costs of personally-owned aircraft, is also applicable to company-owned planes with but a slight variation in the formula.

There are several types of specific costs which go to make up total operating expense. These are: Fuel and oil, maintenance and repair, hangar rentals, insurance, and depreciation.

We'll start building our formula by reducing fuel, oil, and maintenance costs to a common denominator of dollars per hp. hr., since these costs are the only ones that vary with the number of hours you fly. In this way all you have to do is know the horsepower of a ship and how many hours it will be flown and you can then tell how much it will cost you for gas, oil, and maintenance for a year's flying. Add this sum to the more or less fixed costs of the other items and you get the total cost.

The cost of 73 and 80 octane fuel varies generally from 24 to 33¢ per gal. throughout the nation, with the national average being 27¢ per gal. or 4.5¢ per lb., according to a major oil company. The cost of oil also varies, with the national average being approximately $1.30 per gal., or 17.33¢ per lb, according to the same source.

Fuel and oil consumption usually varies with the kind of engine and the horsepower you pull for cruising. Most of our light plane engines will give a fuel consumption of .52 lb./hp.hr. and since most of our flying is done at cruising horsepowers we'll take that figure as representative of the average. Similarly, the figure .0055 lb./hp.hr. has been taken as the figure for average oil consumption, further substantiated by the results of a survey of 518 light airplanes made by CAA in 1942.

With the foregoing constants, the fuel and oil cost in dollars/hp.hr. is then:

Fuel and oil cost in dollars/hp.hr. = (.52 × .045) + (.0055 × .1733) = $0.0243/hp.hr.

If you cruise your plane at 50 hp. that's about $1.21 for fuel and oil every hour you fly, or approximately $181 per year for 150 hr. flying.

The cost of maintenance and replacement parts can vary considerably, depending, among other things, upon CAA regulations governing inspection periods and upon the care given the airplane. In developing a cost factor we'll assume that reasonably good care will be given the airplane under all conditions, that the airplane will be stored in a hangar when not in use for long periods, and that ample insurance coverage will be maintained, covering crash repairs and replacements.

Even though under the amended Civil Air Regulations the plane owner is legally bound to have his aircraft inspected only once a year and keep it airworthy, for our purposes we are going to assume that most owners will consider their necks worth the few extra dollars necessary to have the 20 and 50 hr. engine checks, 100-hr. inspections, 500-hr. engine overhaul, and the major airframe overhaul after 5 yr. of operation.

Cost averages were taken for the above operations for aircraft, ranging from 65 to 250 hp. In translating total costs for the many operations over long periods of time into dollars/hp.hr., the effect of weight relationship to horsepower is considered, since the cost factor includes airframe maintenance cost. Accordingly, costs were considered for aircraft with varying power loadings and varying useful load ratios. The effect of a major airframe overhaul is not included in the maintenance cost factor for the first year of operation of a new plane, but it is included on a sliding scale for the second, third, fourth, and fifth years of operation. The result will be an increase in maintenance costs each year as the plane grows older.

Although the owner may not keep his airplane for a full 5 yr. and thus not incur the actual expense of a major airframe overhaul, the airplane's resale value decreases with each year it gets closer to the overhaul. Consequently this cost effect must be considered, either as an increasing maintenance cost or as a higher depreciation cost factor. It is more technically correct to consider it as a maintenance cost factor.

The resulting cost factors for maintenance, repairs, and replacement parts are then:

1st yr. of operation; $0.0134/hp.hr.
2nd yr. of operation; $0.0175/hp.hr.
3rd yr. of operation; $0.0216/hp.hr.
4th yr. of operation; $0.0257/hp.hr.
5th yr. of operation; $0.0298/hp.hr.

Again at 50 hp. for cruising it would cost you about 67¢ per hour for maintenance, repairs, and parts. That's about $100 a year for 150 hr. flying.

Hangar rental is an imponderable, the cost of which is practically impossible of definition in the strictest sense. Many plane owners will not hangar their airplanes. Others who do will find themselves charged upon a variety of bases, usually having some relation to the size of the airplane. In determining the hangar rental cost factor, average costs of prewar hangar rentals in various parts of the country were considered, together with acceptance of the probability that the size of the airplane will generally dictate the hangar rental. Since seating capacity is usually the simplest indicator of airplane size, this means is taken of establishing the relationship of size and rental charges. The resulting factor is then:

Hangar rental in dollars/year = number of passenger seats × $90.

This would result in a cost of $15 per month or $180 per year for hangaring a light two-place airplane, which is the national average. However, if you are calculating the cost of a particular airplane and your hangar rental is a little different from this factor, the actual figure can be substituted in the formula.

Data supplied by the Civil Aeronautics Authority shows that the average life of all non-military private aircraft at the close of 1938, including destruction, was 7.4 yr. Although on first thought this may seem a little too long a period over which to depreciate an airplane, considering obsolescence and an active new plane market, closer examination reveals that it may be

TABLE I—Personal Aircraft Direct Operating Cost Formula

$$C_a = [(F + M)\ P_{cr} \times U] + N\ 90 + C\ .135 +] (I \times CD) + 45 + (N\ 17\ 50)\ ]$$

$$C_{hr} = \frac{Ca}{u}$$

$$C_m = \frac{Ca}{(V_{cr} - 10)\ U}$$

Where

C_a = Annual operating cost ($)
C_{hr} = Hourly operating cost ($)
C_m = Operating cost/plane mi. ($)
F = Full cost/hp. ($0.0243)
M = Maintenance cost/hp. hr.: 1st yr. new $0.0134; 2nd yr., $0.0175; 3rd yr. $0.0216; 4th yr., $0.0257; 5th yr., $0.0298.
P_{cr} = Engine cruising hp. required to maintain cruising speed.
LL = Annual utilization (flight hr./yr.
N = Number of passenger seats
V_{cr} = Cruising speed (mph.)
I = Hull insurance rate ($): Aircraft with empty weight less than 2,000 lb., .125; over 2,000 lb., .105
C = Original selling price
D = Depreciated value of airplane: 1st yr. new 0; 2nd yr., .80; 3rd yr., .68; 4th yr., .58; 5th yr., .49.

EXAMPLE OF FORMULA

Airplane B: Three passenger capacity, cruising 120 mph. @ 77 hp., costing $3,287.00; assuming utilization of 200 hr. annually. Costs for first year of operation new.

$$C_a = [(.0243 + .0134)\ 77 \times 200] + (2 \times 90) + (3287 \times .135) + [(.125 \times 3287) + 45 + (2 \times 17.50)].$$
$$= 580 + 270 + 444 + 509$$
$$= \$1803.00$$

$$C_{hr} = \frac{1803}{200}$$
$$= \$9.00$$

$$C_m = \frac{1803}{(120-10)\ 200}$$
$$= \$.082$$

accepted as a reasonably sound basis for calculating depreciation.

Market studies have shown that the percentage of potential plane owners who can afford to own and operate a second-hand airplane overshadows those who can afford a new airplane in the approximate ratio of 7 to 1; and in addition it's evidenced that a large proportion of those who have a strong desire to own an airplane are among those many who can only afford a second-hand plane. This may be expected to have the effect of reducing the rate of depreciation and lengthening the active life of the airplane.

It is true that the prices of second-hand airplanes today reflect little if any depreciation, but this is a condition brought about by the war and should be nullified as soon as new airplanes are produced in quantity.

The cost formula is based upon the first 5 yr. of operation, up to the estimated time of major airframe overhaul. Using 7.4 yr. as a reasonably good estimate of the active life of the average light airplane and allowing for a 32.5% residual value at the end of 5 yr. for the remaining 2.4 yr. of active life, the depreciation rate would be 13.5% of original selling price per year for 5 yr. This can be expressed in the formula as:

Depreciation = original selling price (C) × .135. This means that a $2,000 lightplane would decrease in resale value at the rate of about $270 per year.

Insurance rates were reduced recently. It is probable that they will change from time to time in the future, depending upon the accident rate and how much the insurance companies have to pay out in damages per dollar of premium received. This means that the figures used in our formula must be changed when necessary in order to yield accurate results. Rates included in these formulas are for hull insurance, public liability and property damage, and passenger liability.

As quoted by a major insurance company, those for hull insurance are: Aircraft under 2,000 lb. empty weight, $12.50 per $100 of insured value, and aircraft over 2,000 lb. empty weight, $10.50 per $100 of insured value. It must be remembered that there are various types of hull insurance coverage at varying rates. The type for which prices are quoted specifies that the insured value for the first year is 100% of original selling price and for the second year 80%. For succeeding years, through the fifth year, the insured value is 15% less each year. This makes the hull insurance rate fit into the formula as:

.125 × selling price × depreciation

Public liability is quoted at $25 per year for $5,000 coverage, and property damage at $20 a year for the same coverage, making a combined total cost of $45. Passenger liability is quoted as follows:

2-Place aircraft, one passenger—$35 per yr.

3-Place aircraft, two passengers—$55 per yr.

4-Place aircraft, three passengers—$70 per yr.

5-Place aircraft, four passengers—$85 per yr.

For each additional passenger capacity over four: $15 per passenger per year.

In order to simplify the application of the above figures for the formula, a rule of thumb was adopted whereby the rate was assumed as being $17.50 per year per passenger capacity.

There are two underwriting groups offering insurance to the private flyer—the mutuals and the stock companies. Each possesses certain advantages and disadvantages, depending upon the circumstances, so you should investigate the alternate plans to determine the one most satisfactory to your particular case. The rates used here are representative of what the cost is at the present time under average circumstances.

Applying them to a new two-place airplane costing $2,000, the annual insurance cost for complete coverage would be $330. We all know that this rate is very high when compared to the average automobile rate, and often prohibitive for the average private pilot. The only thing we can hope for is that improvement in airplane design plus more careful flying will so decrease the accident rates that lower insurance costs will be forthcoming. The insurance companies will be watching accident trends very carefully during the next year.

Using the example plane previously mentioned—a two-place craft cruising at 80 mph. with 50 hp. and costing $2,000—the annual operating cost according to our formula would be approximately $1,061 for 150 hr. flying, as follows:

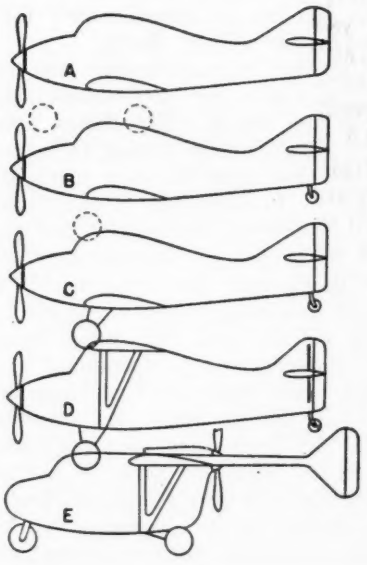
Fuel & oil cost	$181.00
Maintenance, repair & replacement parts cost	100.00
Hangar rental	180.00
Depreciation	270.00
Insurance	330.00
Total annual cost (150 hr.)	$1,061.00
Total cost per hr.	7.08

If you operated the same airplane 250 hr. in a year, the total annual cost

TABLE II—Cost Comparison of Exemplary 3-Place Airplanes*

	A	B	C	D	E
Payload (lb.)	575	575	575	575	575
Rated power (hp.)	129.5	124.5	122.0	137.5	165.5
Cruising power (hp.)	79	77	86	104.5	125.5
Cruising speed (mph.)	120	120	120	120	120
Original selling price ($)	$3,470	$3,287	$3,146	$3,325	$3,850
50 Hr. annual utilization					
Annual operating cost ($)	1,418	1,368	1,348	1,429	1,605
Hourly operating cost ($)	28.30	27.30	26.90	28.60	32.10
Operating cost/plane mi. ($)	.258	.249	.245	.260	.292
100 Hr. annual utilization					
Annual operating cost ($)	1,568	1,513	1,510	1,626	1,842
Hourly operating cost ($)	15.67	15.13	15.10	16.26	18.42
Operating cost/plane mi. ($)	.143	.138	.138	.148	.168
150 Hr. annual utilization					
Annual operating cost ($)	1,716	1,658	1,672	1,823	2,078
Hourly operating cost ($)	11.45	11.05	11.15	12.15	13.85
Operating cost/plane mi. ($)	.104	.100	.101	.111	.126
200 Hr. annual utilization					
Annual operating cost ($)	1,865	1,803	1,834	2,020	2,315
Hourly operating cost ($)	9.32	9.00	9.18	10.10	11.58
Operating cost/plane mi. ($)	.085	.082	.083	.092	.105
300 Hr. annual utilization					
Annual operating cost ($)	2,163	2,093	2,158	2,414	2,788
Hourly operating cost ($)	7.21	6.97	7.19	8.04	9.29
Operating cost/plane mi. ($)	.066	.063	.065	.073	.085

* Re craft types considered in "Designing Tomorrow's Personal Plane," Part II, Ralph H. Upson July, 1945, AVIATION



would be $1,259 or $5.03 per hour, clearly showing the important effect annual utilization has on hourly operating costs. This is because three of the heaviest costs—hangar rental, depreciation, and insurance—are fixed, regardless of the number of hours the airplane is used.

Fitting the pieces together, the formula shown in Table I represents the simplest and most flexible method possible for determining operating costs under variable conditions. It's not nearly so complicated as it looks. A pencil, paper, and 15 min. are all that are necesary to find the cost of operating a given airplane, if you know the passenger capacity, cruising speed, cruising horsepower, and selling price.

To reduce the process to its simplest terms (for those who do not like mathematical formulas), here's what to do: Add fuel and oil costs per hp.hr. (.0243) and maintenance cost per hp.-hr., which varies with the age of the airplane. Multiply this sum by the cruising hp. of the airplane. Then multiply the answer by the number of hours flown per year. Add to this total the annual hangar rental cost, which is the number of passenger seats multiplied by $90 if you don't have a specific cost; depreciation, which is the selling price of the airplane multiplied by .135; and the insurance cost. To get insurance cost add $45, the sum of the number of passenger seats multiplied by $17.50 and the sum of $.125 multiplied by the insured value of the airplane.

In order to determine the factors which have a controlling influence upon operating costs we have selected five three-place aircraft, all of which have the same payload, the same range, and the same cruising speed. Each aircraft differs from the other in design only, principally with regard to wing design and location, landing gear type, and engine location. They are the five aircraft developed for study by Ralph H. Upson in Part II of his series "Designing Tomorrow's Personal Plane," July, 1945, AVIATION. Their principal characteristics and operating costs are shown herewith in Table II.

The selling price of each airplane was calculated in the same way, using the same constants for engine costs, purchased material and parts costs, labor and tooling costs, overhead costs, profit margin, and dealer discount. From the standpoint of selling price, Airplane C, the cantilever low-wing tractor with fixed conventional gear, is the cheapest to build and sell by a considerable margin, especially over the more conventional high-wing types.

However, Airplane B would actually be the cheapest to own and operate

TABLE III—Cost Comparison of Exemplary 2-Place, 3-Place, and 4-Place Aircraft

	2-Place Aircraft	3-Place Aircraft*	4-Place Aircraft
Payload (lb.)	400	575	760
Rated power (hp.)	85	124.5	165
Cruising power (hp.)	53	77	103
Cruising speed (mph.)	120	120	120
Original selling price ($)*	$1,990	$3,287	$5,036
*	*	*	
Annual operating cost (200 hr.)	$1,178.00	$1,803.00	$2,563.00
Hourly operating cost (200 hr.)	5.88	9.00	12.82
Operating cost plane mi. (200 hr.)	.054	.082	.117
Operating cost/seat mi. (200 hr.)	.027	.027	.029
Annual operating cost % of original selling price	59.0%	59.0%	50.5%

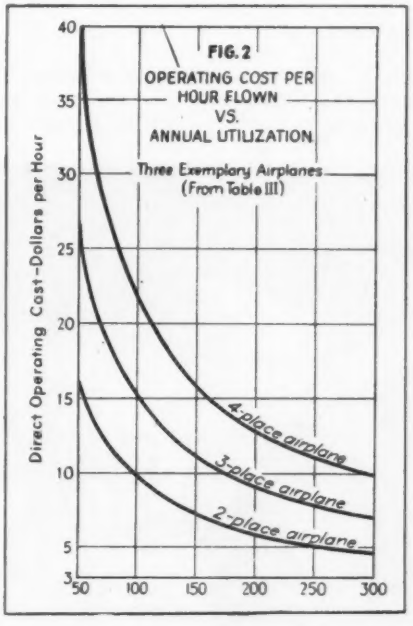
* Airplane B from Table II

* Selling prices calculated by same method for purely comparative purposes, assuming maximum design and production efficiency.

even though it would cost more to buy. Though you have to pay a few dollars more for that retractable gear, the airplane will, in the long run, cost less because it will achieve the same performance with considerably less power output, resulting in less fuel, oil, and maintenance costs.

While Airplane A would never equal the cost efficiency of Airplane B, after 300 hr. of operation it is more economical than Airplane C even though its initial cost is considerably higher. This shows that the charter service operator would benefit substantially by operating the more efficient airplanes, since his annual utilization is usually considerably higher than that of the private owner. The high-wing conventional tractor and pusher designs, Types D and E, are easily the most inefficient from an operating cost standpoint.

The comparison of these five aircraft indicates that the most important factor controlling cost is design efficiency. Improved design, with an eye to cost efficiency, is essential to the reduction of high owning and operating costs.



Such improvement should be aimed at reducing the airframe weight and horsepower necessary to accomplish the job required, resulting in less labor, tooling, and material. This will make possible a reduction in maintenance and fuel costs and a lower selling price with a consequent reduction in the cost of insurance and depreciation.

Improvements may also be hoped for in fuel costs, insurance rates, and hangar rentals. For example, if the same fuels could be used in aircraft engines as are used in automobile engines, fuel cost per year for our example airplane cruising at 50 hp. would drop from $181 to $137 for 150 hr. flying. Introduction and use of the T-hangar should lead to lower hangar costs, especially when such hangars are produced in quantities permitting the use of mass production techniques. Insurance rates, as stated before, will depend upon the safety record of personal owners and fixed base operators alike.

Analysis of the various factors controlling cost of light airplane operation has spotlighted another significant fact, the understanding of which can be of use in the development and sales planning of future personal aircraft. A lightplane with low initial cost will often be the logical choice for the flyer using it for limited pleasure transportation on a limited budget, where annual dollar outlay is the principal cost criterion.

On the other hand, a lightplane with substantially higher initial cost but with greater performance may often show a lower per-mile cost than the less expensive plane, making the higher priced plane more efficient for business transportation purposes to both the personal owner and the charter operator.

Market surveys have shown that a substantial lightplane market potential exists in our nation, providing that utility can be increased and that annual operating expense can be as low as 40% of original selling price. This stresses the importance of materially decreasing operating cost of lightplanes in the coming postwar years.

MARKETING

Flexible sales arrangements with large retail department stores opens new distribution outlets to aircraft, parts, and accessory producers and to individual fixed base operators. So now it's—

SELL AIRPLANES OVER THE COUNTER

THE GROWING wave of publicity arising from the increasing number of large department store tieups with aircraft manufacturers and distributors has raised two questions important to personal plane production and sale.

First, will such connections actually boost the long-range distribution of lightplanes—can they become a permanent association of value to the industry?

Second, will they be of benefit to the fixed base operators, those who have been the foundation of the personal plane distribution system?

In both cases the answer can be in the affirmative for, as the pattern is developing, tying up with organizations built on merchandising know-how can be of material assistance to the aircraft industry all the way from the manufacturer to the individual dealer. The aircraft industry has much to gain and little, if anything, to lose if the department store connections are properly established and followed up.

Three basic types of permanent department store deals have developed thus far, and in each case they supplement rather than supplant the always-necessary work done at the airport.

One type, that of a straight dealership under a manufacturer's regular distributor, is that exemplified by Marshall Field & Co. in Chicago. Here the department store has been appointed Ercoupe dealer by Engineering & Research Corp.'s mid-western distributor, Parks Aircraft Sales Co.

Under such a setup, the department store uses its display and sales techniques to get the prospective customer ready, willing, and able to make the necessary visit to the distributor's base of operations, where he can be gotten into a plane for the always-essential demonstration flight. Having the store as a dealer, and thus with a continuing interest in making sales, makes the arrangement more than a downtown showroom.

A similar arrangement has been made by Tufts-Edgecomb, Chicago distributors for Piper Aircraft, in which Mandel Bros. department store has been appointed a dealer. The Piper distributor will continue to provide flight instruction, service, and hangar facilities.

An additional tie-up is planned for this month with a large Richmond, Va., department store by the Piper distributor in that area.

Another type is that in which the department store is made a sub-dealer, as is the case in New York City where the John Wanamaker organization is affiliated with Safair, Inc., metropolitan area distributor for Piper.

Under this arrangement the distributor maintains trained sales personnel at the permanent display—in this case comprising a Skycycle craft mounted atop 5-ft. high pedestals in a broad main aisle at the base of a wide stairway, at the top of which are set a J-3 Trainer and a Super Cruiser. Such a contract means a minimum of investment for the participating store, since allocation of space is the major factor. And even this is held to a low point, since there is adequate headroom under the wings of the centrally-located single-place plane, and one wing of each of the other two models extends out over the railing of the balcony on which they are located. Thus the planes are arranged so as to catch the eyes of a maximum number of patrons

Piper Skycycle mounted on pedestal in main aisle of John Wanamaker's New York City store. In full view, but without blocking customer space, this plane is at base of stairs flanked by two other models on balcony just above. In this department store tie-up, local Piper distributor maintains sales personnel at display which is considered "pre-seller" for final work to be done at airport.

Edwin F. Mandel, president of Mandel Bros., looks over Piper first put on display in his store's aviation department. Mandel's functions as dealer under Chicago area Piper distributors, who handle instruction, service, and hangaring.

without taking up the floor space normally required by aircraft.

Safair officials feel that having the store as a subdistributor is a very efficient means of lining up prospects, pointing out that "a department store is the ideal place to repeatedly expose people to the planes—expose them enough so that eventually they'll come to the airport and get in a plane for a demonstration flight, which means they're more than half sold."

The third type of distribution tieup is that where a major department store works directly with the manufacturer, cooperating with already-established local dealers located at airports. Such is the setup just established with Ercoupe by R. H. Macy & Co. in New York City.

Here the retail merchandising organization has established a display and has provided trained sales personnel to staff it. Contracts have thus far been worked out with four Ercoupe dealers at nearby fields where demonstration flights and "sales closing" work will be done. These dealers will also take care of flight instruction, hangaring, and service work at the fields, although all arrangements for these items can be made directly with the store, which also has worked out time-payment plans.

It is in every sense a cooperative venture, Macy Vice-Pres. Elliott Walter told AVIATION—a cooperative venture with the established fixed base operators. "We can," he said, "do the preselling here at the store, complementing the efforts of the operators at the fields. It is a two-way affair."

It is interesting to note that twelve planes were sold the first day the "Flight Deck" was open.

Although the final selling pattern has not yet been worked out—it can only be completed with more experience—the department store expects to have fixed fee service and overhaul charges. In the matter of engine overhaul, for example, it is planned to have a fixed-fee arrangement which would, so far as the owner is concerned, mean simply a complete engine change which would mean a matter of hours rather than days that his craft would be out of service.

Macy's expects to have similar aircraft sales and service tie-ups with Ercoupe in other areas where it has affiliated stores—Newark, N. J.; Atlanta, Ga.; Toledo, Ohio; and possibly at San Francisco, Calif.

In addition to these sales outlets which are planned as permanent merchandising programs, many temporary displays—which might easily become permanent—are being planned for the near future. Macauley Adams Associates, of New York City, has just arranged with Ercoupe for one to two-week displays in 40 to 50 cities, beginning with Boston, Philadelphia, Buffalo, and Joliet, Ill.

From the standpoint of both aircraft manufacturers and distributors, as well as parts and accessory producers, it would appear that either temporary or permanent connections with large well-established retail organizations can be of material benefit in many ways, for not only is extremely valuable showroom space thus acquired, but association with merchandising know-how can't help but have a lasting effect. Too, the flexibility of such connections makes them easily adaptable to local conditions, either when established by the manufacturer or by the individual aircraft dealer.

Typical of advertising currently being done by department stores is this eye-catcher by Bamberger's of Newark, N. J., as Ercoupe sales plan was announced, with three nearby fixed base operators tied in on program.

FINANCE

With Ready Money Mounting It's "Cash and Carry-On"

By **RAYMOND L. HOADLEY,** *Financial Editor, "Aviation"*

Our industry is accumulating financial wherewithal in the form of tax savings, refunds, and termination payments. And with favorable legislation now smoothing the path ahead, we can look for a strong drive to build—and consolidate—earning power.

MILLIONS OF DOLLARS in ready cash are coming into the coffers of aircraft companies over the next few months in tax savings and refunds—to aid the industry in hurdling its difficult reconstruction problems and to provide funds for programs involving new developments and the expansion of civilian markets.

The Tax Adjustment Act of 1945 probably didn't mean much to the average taxpayer, but it means a lot to the aircraft industry.

Fact is that although the industry's $20,000,000,000 war volume has suddenly vanished like the bursting of a big soap bubble, the cash positions of aircraft companies continue to improve—a far cry from the postwar bankruptcy once so generally feared.

New tax legislation already on the books and other tax laws now pending are playing an important part in this enhanced financial picture for the industry. So the aircraft tax situation, present and prospective, merits the careful consideration of everyone interested in aviation.

The Tax Adjustment Act is worth $5,000,000,000 to American business. Let's see, accordingly, how the aircraft industry comes off:

Beginning with the 1946 tax year the excess-profits exemption will be boosted to $25,000 from $10,000. This provision doesn't mean much to the industry, except possibly some of its smallest units. And anyway, it may prove a dud as a relief factor, since the excess profits tax may be wiped off the books in pending tax legislation.

In the next provision, however, we begin to strike gold. Under the war tax laws, corporations earning in excess of their normal prewar profits paid an excess profits tax of 95%, but were entitled to a postwar refund of 10% of the tax paid.

This was represented by non-interest bearing government notes not redeemable for from 2 to 5 yr. after the end of the war. The 1945 adjustment measure speeded up the payments by providing that refunds due on 1942 and 1943 taxes be paid, at the taxpayer's option, on or after Jan. 1, 1946. Furthermore, it provided that the refund applicable to 1944 taxes, and payable in 1945, be taken up currently.

For a hypothetical case, assume that the John Doe Aircraft Corp. reported an excess profits tax liability of $1,000,000 for 1944. It paid the first quarterly installment of $250,000 on Mar. 15 and a like amount on June 15. Under the old law, the company would, when it completed its payments for the year, get a credit of 10 percent or $100,000 in government notes due several years after V-J Day.

Under the new law the company used half of the credit to reduce its September tax installment to $200,000 and will do the same in December. It will get no credit notes. And next year it will pay only $225,000 a quarter, assuming an equal tax liability for 1945. In addition, of course, the John Doe Aircraft Corp. will substantially increase its cash funds on Jan. 1, 1946, by cashing in on its postwar credits of, say, $200,000 for 1942 and 1943.

Thus it is that the corporations which paid the highest excess profits taxes during the war will get the biggest refunds. And that means the aircraft industry. Here are some of the refunds that were due companies in the industry at the end of 1944: Boeing, $8,000,000; Curtiss-Wright, $16,600,000; Bendix, $14,100,000; Martin, $8,600,000; Douglas Co. $7,000,000; North American Aviation, $6,700,000; Lockheed, $5,700,000; Grumman, $5,500,000; United Aircraft, $4,200,000; and Consolidated Vultee, $2,100,000. This is all "conversion money" that the industry can get now instead of waiting several years for it.

Speeded up cash payment benefits of the 1945 revenue act do not stop with the 10 percent refund. There is also the matter of possible carry-backs and adjusted amortization claims. Early in the war, when the wartime tax laws were being written, industry clamored for the right to set up reserves to cover such costs of war operations as deferred maintenance, reconversion, etc.

Congress and the Administration agreed that all such expenses were properly war costs and chargeable to profits. But the Treasury opposed such deductions because of the difficulty of estimating such costs years in advance. Instead, it offered the carry-back provisions to compensate industry. Briefly, the carry-back provision states that companies can receive refunds resulting from carrying back to tax returns of prior years the net operating losses incurred in the current year. Present prospects are that the carry-

back provision will be retained through 1946 even though the excess profits tax is abolished at the end of 1945.

The aircraft industry appears bound to experience a sharp recession in earnings next year. Under the law, a company whose earnings fall below its excess profits credit may apply or carry back the unused portion of its credit to the second previous year, add it to the credit for that year, recompute its tax, and get a refund. If all the unused credit is not thus used, the remainder may be applied to the subsequent year in the same way. If operations result in a deficit, this deficit may be similarly carried back.

Normally no refund would be made for several years, or until the tax accounts were finally audited. However, the law now provides for payment of the refund within 90 days without the complete audit.

Naturally, the carry-back will benefit some companies more than others. One company, for example, expects to sustain operating losses in both 1946 and 1947. That company will be aided substantially by the carry-back provision. Some other aircraft companies that expect moderate profits next year wouldn't receive much, if any, aid.

Douglas and United Aircraft are two companies which had high enough "bases" of normal prewar earnings to be in line for refunds. Douglas, it is estimated by the *Wall Street Journal*, should begin to get refunds if 1946 profits dip below $9,000,000. The company earned $37,300,000, in 1944. United's refund level is around $16,000,000 compared with its 1944 net of $64,000,000.

Where carry-back will come in handy will be in connection with experimental work—and the industry is faced with a staggering amount of experimental work, probably trending toward a big loss in the near future. But the loss would run only 20 to 30¢ on the dollar in cases where the carry-back provision is operative.

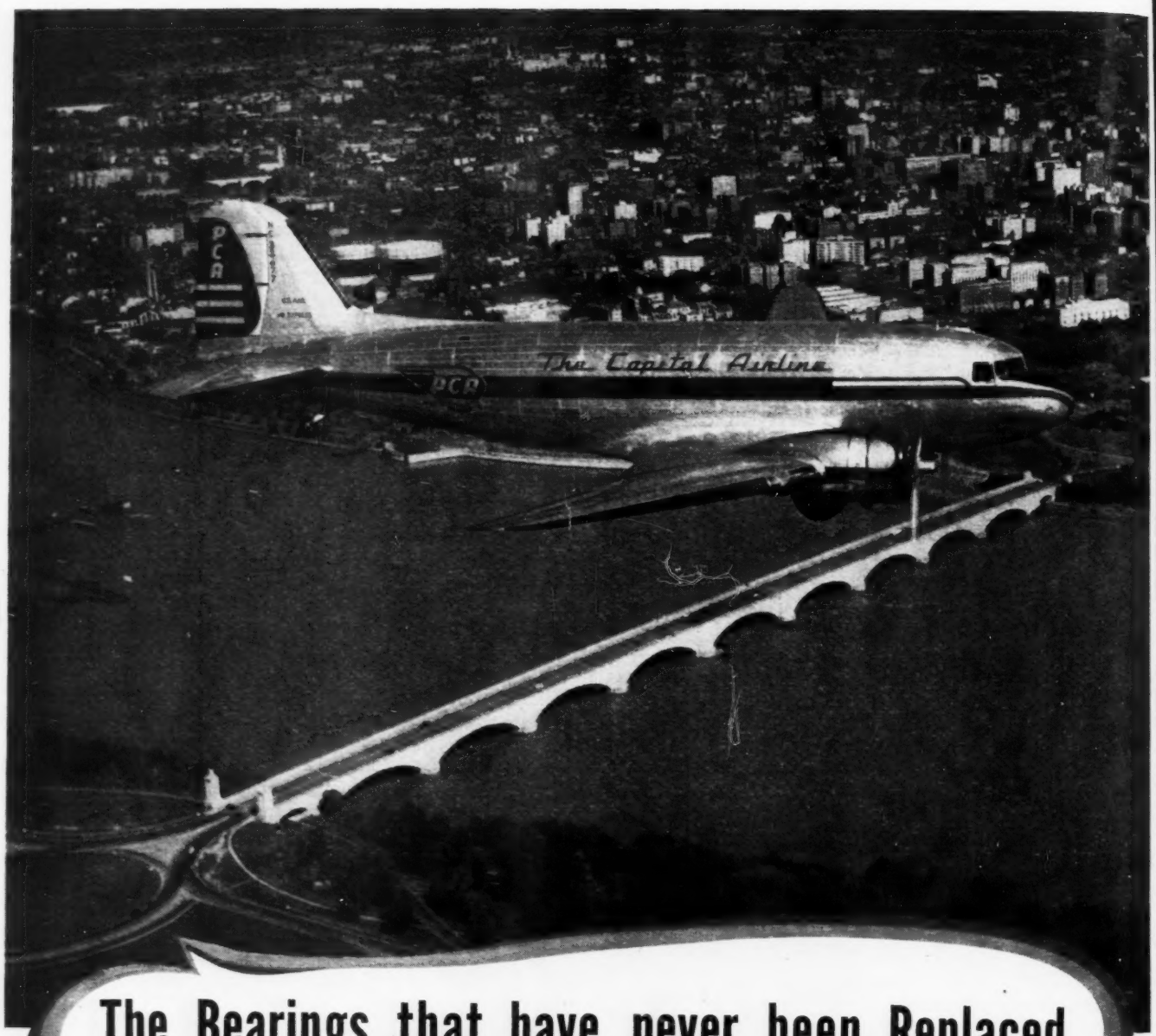
There is one more important benefit from the 1945 tax adjustment law—that is, in relation to amortization of war facilities. Aircraft companies that built or installed plants under a certificate of war necessity were permitted to amortize the cost over a 5-yr. period. The Government has issued a declaration that these facilities no longer are needed for the war effort. That means that an aircraft company now may recompute its amortization to cover the shorter period and reduce taxes for the years in which the plant actually was used for war purposes.

Under the adjusted tax act, refunds due to accelerated war facility amortization must be paid within 90 days of the filing of the claim. The total of amortization refunds to be made runs something like $1,700,000,000 for all industry. The aircraft industry will, of course, figure heavily in this total.

For example, Lockheed's unamortized war plant balance at the end of 1944 was around $11,900,000. If the company elects to speed up amortization it appears to be in a position to collect more than $5,000,000 in refunds. Likewise, the latest balance sheet figures available indicate that Curtiss-Wright could claim more than $4,000,000, and Consolidated Vultee something like $5,000,000.

Repeal of the excess profits tax will be welcomed by the aircraft producers. But if the repeal is effective as of Jan. 1, 1946—as expected when this was written—it will not be of as much aid as it would if the tax were also taken off 1945 earnings. However, there are some companies, with big backlogs, whose 1946 earnings might be aided considerably by elimination of this war tax.

All in all, it will be seen that tax refunds, together with termination payments, will bring a steady flow of cash to the industry over the next few months. Granted, it's one thing to have a comfortable cash position, but something else again to have current earning power. The fact is, however, that the aircraft industry today is well fortified with working capital instead of facing bankruptcy, as so many of the industry's leaders feared not so long ago. The next thing will be to translate that "seed money" into earning power.



The Bearings that have never been Replaced

The six sturdy Timken Bearings in the main landing gear of the PCA Capitaliner shown above have never been replaced, even after thousands of landings under all conditions.

What's more, according to John Dale, PCA's lead mechanic, "No Timken Bearings have *ever* had to be replaced in the main landing gear of *any* PCA Capitaliner!"

Typical of the many outstanding performance records established by Timken Bearings for PCA is that of the veteran Capitaliner "Cleveland", which, in the words of Barney Vierling, PCA's Chief Engineer, "has just rounded out 16,761 hours of flight time. The "Cleveland" was drafted for military service by the Army Air Corps early in the war and has just recently been returned to PCA and is flying again on our regular routes."

"On the basis of airline estimates," Vierling continues, "this plane has made a total of 13,027 landings — averaging four landings for every three hours of flight during military service, and one landing per hour during commercial work."

★ ★ ★

If stamina like this—plus the other unique features of matchless Timken Bearings —can work for you, write us. Our engineers will be glad to make specific recommendations. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

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TAPERED ROLLER BEARINGS

DESIGN ANALYSIS OF

Messerschmitt Me-262 Jet Fighter

Part II—The Power Plant

By **JOHN FOSTER, JR.**, *Managing Editor, "Aviation"*

First complete engineering study ever published on jet power plant reveals, in addition to fundamental principles of jet propulsion, the design and production compromises made necessary by limitations of materials.

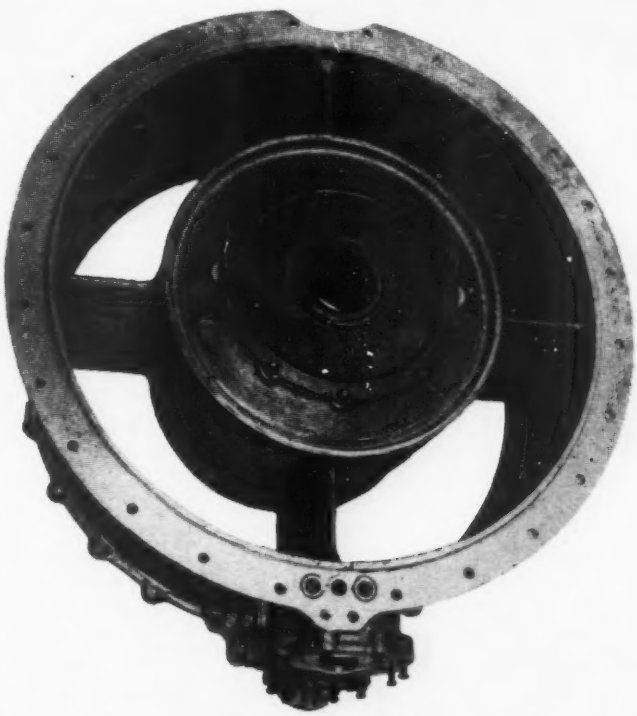
As is the case with the airframe of the Me-262, the Junkers Jumo 004 axial flow gas turbine jet power plant is a compromise between design desire and available materials and production facilities.

Outstanding evidence of compromises resulting from lack of materials is the fact that more than 7% of the air taken in is bled off for cooling purposes. Despite this, however, most engines were found to have a service life of about only 10 hr., against a "design life" of 25-35 hr. Additional compromises are evident in the design, which shows that the production engineer—undoubtedly hampered by lack of both plant facilities and adequate skilled labor—has been as important a factor in its construction as was the designer.

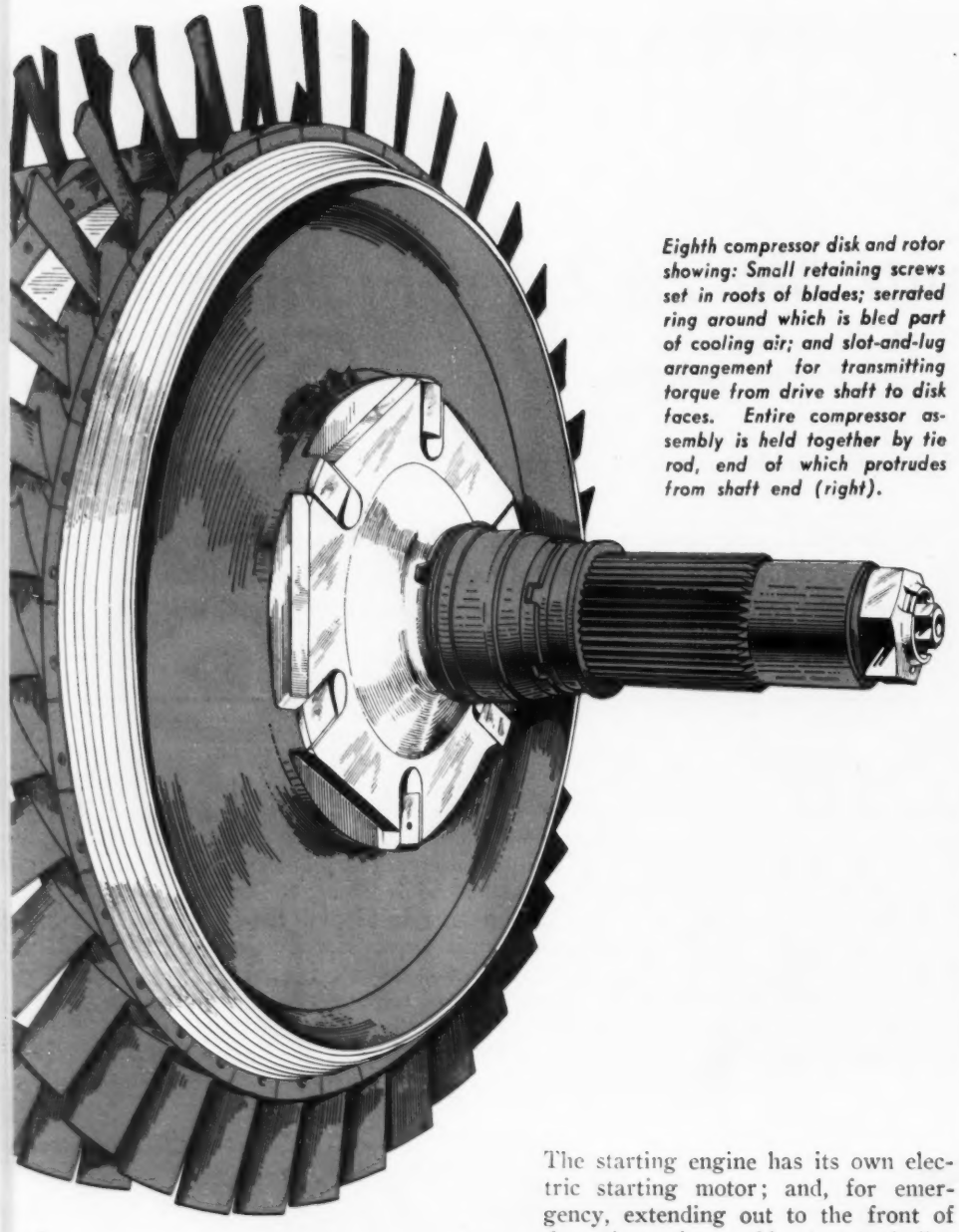
But the Germans had made real progress in overcoming materials difficulties, for just after they capitulated it was discovered that development of a new alloy of excellent heat-resistant qualities had made it possible to get up to 150 hr. service in actual flight tests, and up to 500 hr. on the test stand.

A large unit, the 004 is 152 in. long from the intake to the tip of the exhaust; 30 in. in dia. at the skin around the six combustion chambers, with maximum diameter of the cowling reaching 34 in.

The circular nose cowling is double skinned, the two surfaces being welded together near the leading edge and held in position by riveted channel shaped brackets. Diameter at the intake end is 20 in., the outer skin increasing to 31½ in., the inner to 21½. Inside the cowling is an annular gasoline tank which is divided into two sections, the upper being of ¾-gal. capacity feeding fuel to the starting engine, the lower of 3¾-gal. capacity,



Front of Junkers Jumo 004 intake casting (left), with oil lines at bottom. Holes in outer flange are for attaching oil and starting-fuel tank assembly. Twelve studs on inner ring hold bevel gear assembly, from which drives for accessories and oil pumps extend through vertical streamlined fairings. Right: Aft face of intake casting, with front compressor bearing held in place by round plate attached to ten studs. Bolt holes in outer flange are for attachment to compressor stator casting.



Eighth compressor disk and rotor showing: Small retaining screws set in roots of blades; serrated ring around which is bled part of cooling air; and slot-and-lug arrangement for transmitting torque from drive shaft to disk faces. Entire compressor assembly is held together by tie rod, end of which protrudes from shaft end (right).

Junkers Jumo 004 Weight Table

Intake		
Casting with oil pumps, filter	57 lb.	
Bevel gear assembly & drive shafts	18 lb.	
Gear box & drives	35 lb.	
Front compressor bearing assembly	25 lb.	135 lb.
Compressor		
Stator casting & blades		200 lb.
Rotor with stub shaft & tie rod		220 lb.
Center Section		
Main casting & fittings	163 lb.	
Utter casing & fittings	100 lb.	
Rear compressor bearing assembly	6½ lb.	
Front turbine bearing assembly	7½ lb.	
Rear turbine bearing assembly & scavenge pumps	9 lb.	286 lb.
Combustion		
6 chambers burners, igniters, & interconnectors		116 lb.
Turbine		
Inlet ducting & joint rings	42 lb.	
Nozzle assembly	43 lb.	
Diaphragm plates	10 lb.	
Disk & blades (solid)	151 lb.	
Shaft, sleeve, fittings	30 lb.	
Compressor coupling		7 lb.
Exhaust		
Bullet assembly		190 lb.
		0
		1,430 lb.
Accessories		
Oil tank	27 lb.	
Fuel pump	9 lb.	
Governor	17 lb.	
Tachometer	1½ lb.	
Air-oil separator	4 lb.	
Bullet control servo motor	17½ lb.	
Drive shaft for bullet	4 lb.	
Fuel filter	2 lb.	
Fuel non-return valves	1 lb.	
Throttle linkage	7 lb.	
Misc. fittings & attachments	25 lb.	115 lb.
Engine mount brackets	15 lb.	
Starter		
Starter engine	36 lb.	
Gasoline tanks & supports	20 lb.	
Gasoline pump	6 lb.	
Igniter coils	3 lb.	65 lb.
Net dry weight with starter		1,625 lb.
Accessories		
Generator fittings	36 lb.	
Hydraulic pump	8 lb.	44 lb.
Cowling		
Starter engine cowling	4 lb.	
Starting fuel tank cowling	17 lb.	
Remainder of cowling	85 lb.	106 lb.
Total dry weight, completely cowled engine		1,775 lb.

feeding starting fuel to the combustion chambers.

The nose cowling attaches by eight screws in captured nuts to the annular-shaped combination oil tank and cooler. Having 3-gal. capacity, this tank has a baffle close to the inner surface so that as warm oil is fed in from the top it is cooled as it flows around to the bottom of annulus and the tank proper.

The oil tank, in turn, is attached by 23 bolts on a flange to the aluminum alloy intake casting. This unit comprises the outer ring, with flanges on both front and rear faces, four hollow streamlined spokes, and the inner ring.

Moving back to the front of the unit, though, we find inside the nose cowling a fairing which looks just like a propeller spinner, increasing in size to 12 in. at the intake casting, leaving approximately 220 sq. in. intake area. This spinner houses the starting engine, a two-cylinder, two-cycle, horizontally opposed gasoline engine which develops 10 hp. at 6,000 rpm. The starting engine has its own electric starting motor; and, for emergency, extending out to the front of the spinner is a cable starter similar to those found on outboard boat engines. The engine is 12½ in. long, 10 in. wide, 8¼ in. high, and weighs 36 lb.

The starter engine is bolted to six studs in the bevel gear casting, which contains gears to drive the accessories. Each of these gears is carried by ball and roller bearings, with the drive shafts fitting into internally splined stub shafts on the bevels. There are two drive shafts extending through two of the hollow fairings of the intake casting, one going up to the accessory case which is mounted atop the intake casting, the other extending down to the main oil pumps, which are set inside the lower part of the intake casting.

The bevel gear casting, also of aluminum alloy, is bolted to twelve studs set in a flange in the front face of the intake casting.

The rear side of the intake casting's inner ring is cup-shaped, housing the front compressor bearing. This unit is comprised of three thrust races—each with 15 bearings—mounted in steel liners set in a light hemispheric-shaped housing which is kept in contact with the female portion of the intake housing by the pressure of ten springs held in place by a plate bolting to the intake casting. The outer bearing races are mounted in separate sleeves which fit on the compressor shaft.

This design not only allows for preloading the bearings during assembly to insure even distribution of thrust, but the bearing assembly can be left intact during disassembly simply by withdrawing the compressor shaft from the inner sleeve.

Next in the fore-to-aft sequence is the aluminum alloy stator casting, which is built in top and bottom halves held together longitudinally by eleven ⅜-in. bolts through flanges on each side, with attachment to the intake

casting by 24 ⅜-in. bolts through a heavy flange. Running the entire length of the bottom half of the casting are three .7-in. dia. passages, one serving as part of the oil line leading to the rear compressor and turbine bearings, one connecting oil sumps (which are located in both intake and main castings), and one serving as part of the oil return line from a scavenge pump set in the rear turbine bearing housing.

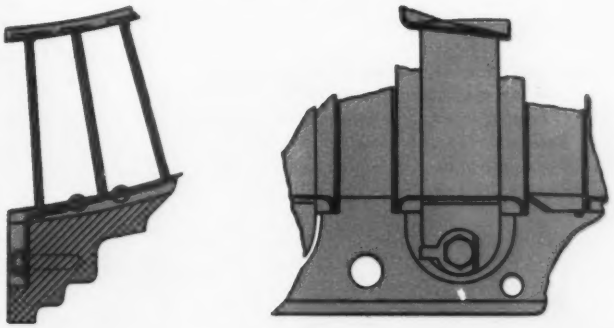
Just aft of the fourth compression stage in both halves of the stator casting is a slot, inside of which is a ring with a wedge-shaped leading edge pointing upstream and set to leave a .08-in. opening to bleed off air for part of the cooling system (which will be discussed later in a separate section).

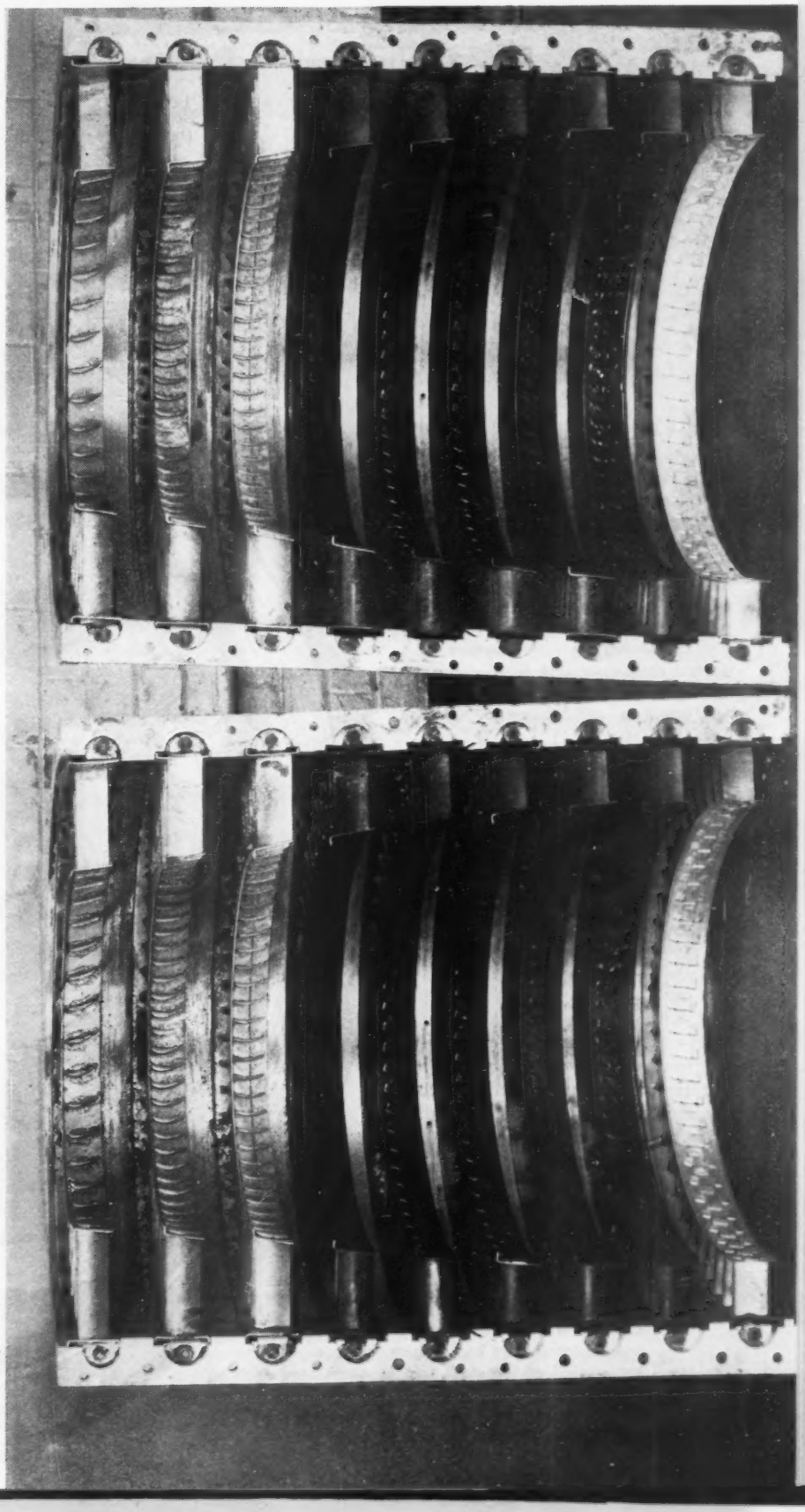
Like the stator casting, the stator rings, which consist of inner and outer shroud rings and stator blades, are built as subassemblies, then bolted in place and locked by small tabs.

Considerable variation, both in materials used and methods of construction, was found in this section. In early production units, for example, the inlet guide vanes and first two rows of stator blades were of stamped aluminum with airfoil profiles; and in assembly, ends of the blades had been pushed through slots in the shroud rings and brazed in place. In other early engines, the third stator row varied both in material and method of attachment. In some cases it would be of aluminum, but without airfoil; in others it would be of steel with the ends turned to form flanges which were spot welded to the shroud rings. The remainder were stamped sheet steel, zinc coated.

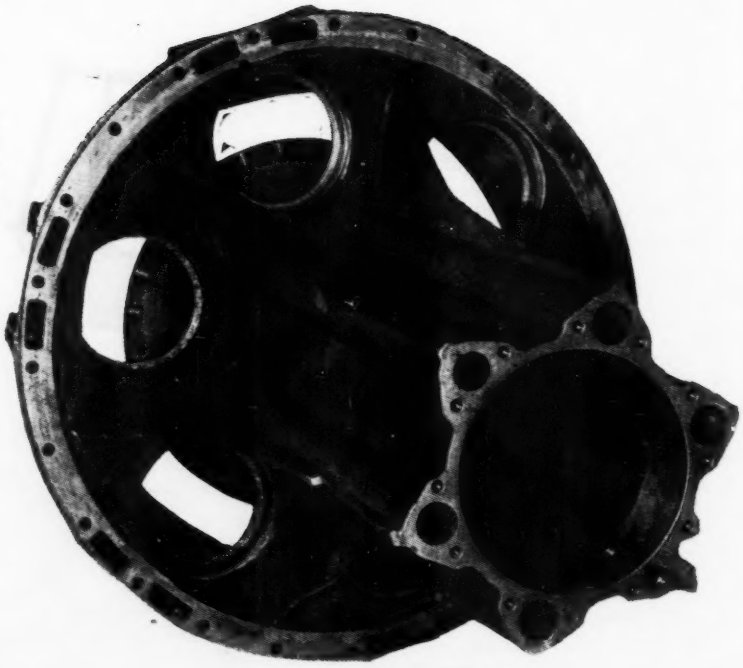
One late-production engine examined showed a combination of all the variations, with inlet guide vanes and first two rows of stator blades of stamped aluminum, and the rest steel, indicating the Germans may have been swinging over from aluminum to steel exclusively. Apparently all the steel blades had been enameled, but this protective coating on the last row, where temperatures reached approximately 380 deg. C., appeared to have been burned off.

Methods of attaching blades to shroud rings also varied. On the inlet guide vanes and first two rows, the

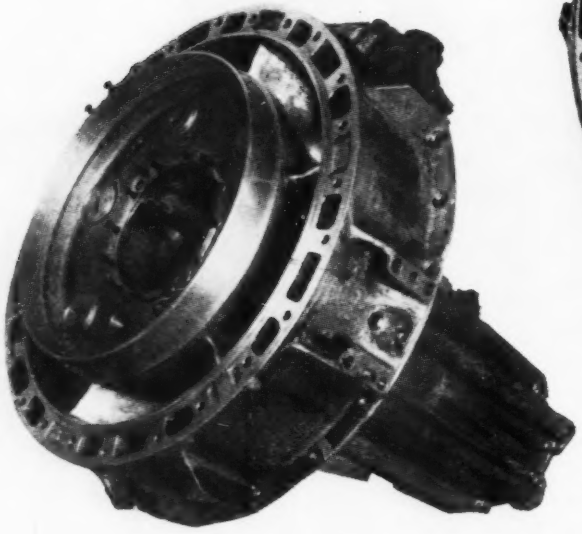




Top and bottom halves of stator casting. These sections are bolted together longitudinally, with flange on front end bolting to intake casting, that on aft end to main casting. Light colored blades are aluminum, darker are enameled mild steel. Germans were evidently changing over from aluminum to steel blades throughout stator at war's end. Sketches at top show method of attaching stator blades.



Rear view of main casting showing rectangular cooling air passages and the six combustion chamber inlets. Five large cored passages in base of ribs are cooling air passages, smaller is oil line. Aft turbine bearing fits in rear end of this casting.

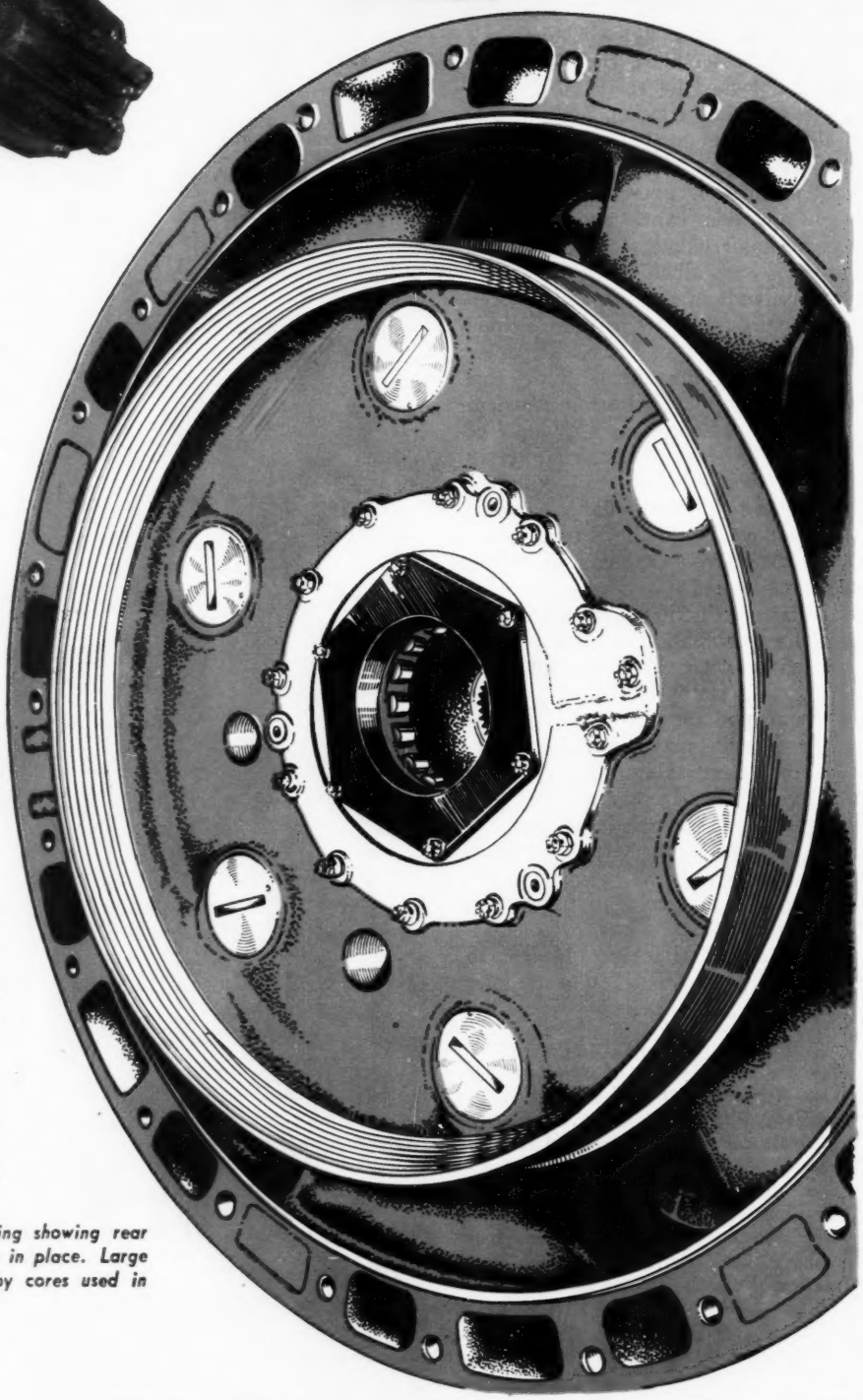


Three-quarter front view of main casting which supports entire engine. At top is engine attachment fixed to one of six possible engine pickup points spaced around unit. Rectangular openings in front outer rim are cooling air passages, and air inlets from compressor to combustion chambers are between faired struts between chambers and serrated ring. Air passing between the serrations and those on last compressor disk is also used for cooling. Studs around center core are for attaching aft compressor bearing housing.

ends of the blades had been pushed through slots in the shroud rings and brazed in place; the 3rd, 6th, and 7th rows had a weld all around the blade end; the 4th, 5th, and 8th row blade ends had been formed into split clips which were spotwelded to the shroud rings.

The outer shroud rings are channel shaped with an angle bracket riveted to each end, this bracket in turn being bolted to a stud set in the casing just inside the mating flange. Inner shroud rings are flanged along the leading edge, with the exception of the 7th row, which is channel shaped.

Except for the inlet guide vanes and the last row of stator blades, which act as straighteners, stator blades are arranged as impulse blading—they are set at nearly zero stagger and simply



Closeup of front of main casting showing rear compressor bearing and housing in place. Large screws seal off passages left by cores used in making casting.

serve as guides to direct the airflow into the rotor blades.

The compressor rotor is made up of eight aluminum disks held together by twelve bolts each through shoulders approximately at mid-diameter, with the entire unit being pulled together by a 38.75-in. long, .705-in. dia. tie rod which has been estimated to have a stress of some 40,000 psi., with a force to pull the assembly together figured at about 16,000 psi.

Diameters of the disks increase from the low to high pressure ends as follows: Stage 1, 13.86 in., Stage 2, 14.68 in., Stage 3, 15.61 in., Stage 4, 16.44 in., Stage 5, 17.18 in., Stage 6, 17.85 in., Stage 7, 18.24 in., and Stage 8, 18.34 in.

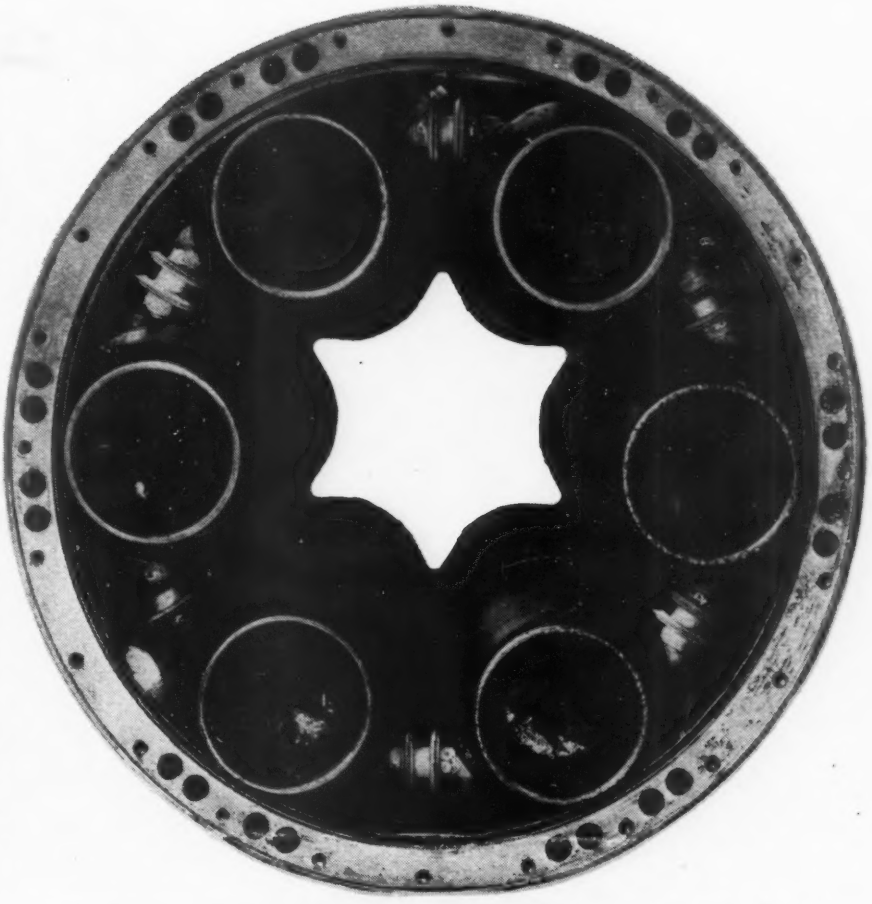
To carry the compressor bearings there is attached to each end disk a steel shaft with an integral disk carrying a round-faced washer. This shaft goes through the disk and is tightened by a nut so that the face of this washer (rounded to facilitate alignment) bears against the disk face. The flange on the rear shaft has six slots around its outer edge, into which fit projections on the rear disk. Thus torque is transmitted from the turbine to the rear compressor disk, and from there on to the other disks by the bolts previously noted as fastening the disks together, the torque being transmitted to the compressor unit around the faces, rather than through a central shaft.

Compressor rotor blades, of which there are 27 in the first two stages, 38 in the rest, are all stamped aluminum with machined roots fitting into pyramid shaped slots in the rotor disk. Through the aft face of each blade root, directly under the blade trailing edge, is a small screw set longitudinally and extending into the disk.

Tip stagger of the blades is about the same through the first six stages of compression, but increases in the last two. Chord of the blades decreases through the eight stages as follows: 1.95 in., 1.94; 1.34; 1.33; 1.30; 1.30; 1.24; and 1.21.

Blade profiles in the first two stages are very similar (possibly even designed to the same section), while the third stage has a thicker section. Stages 4, 5, and 6 have thinner sections (here, too, possibly the same), with about the same chord as Stage 3, while the last two stages, though set at greater pitch and having slightly narrower chord, have generally similar camber and profiles.

Clearances between the rotor blades and the stator casting are .103 in. over the first three stages and .04 over the remaining five. Axial clearances between rotor disks and inner stator shroud rings range from .1 to .15 in., and axial clearances at the roots be-



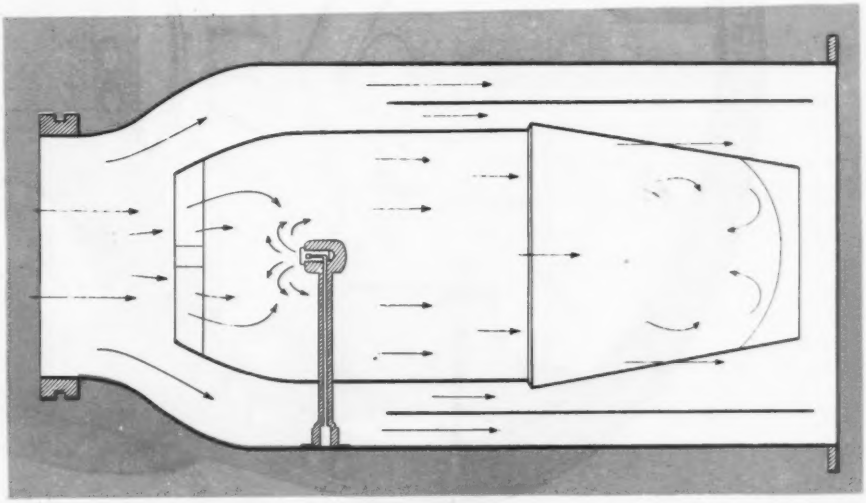
Head-on view of combustion chamber casing with combustion chambers and ignition interconnectors and plugs in place. Every other chamber has ignition plug.

Number of Blades, Compressor—Stator

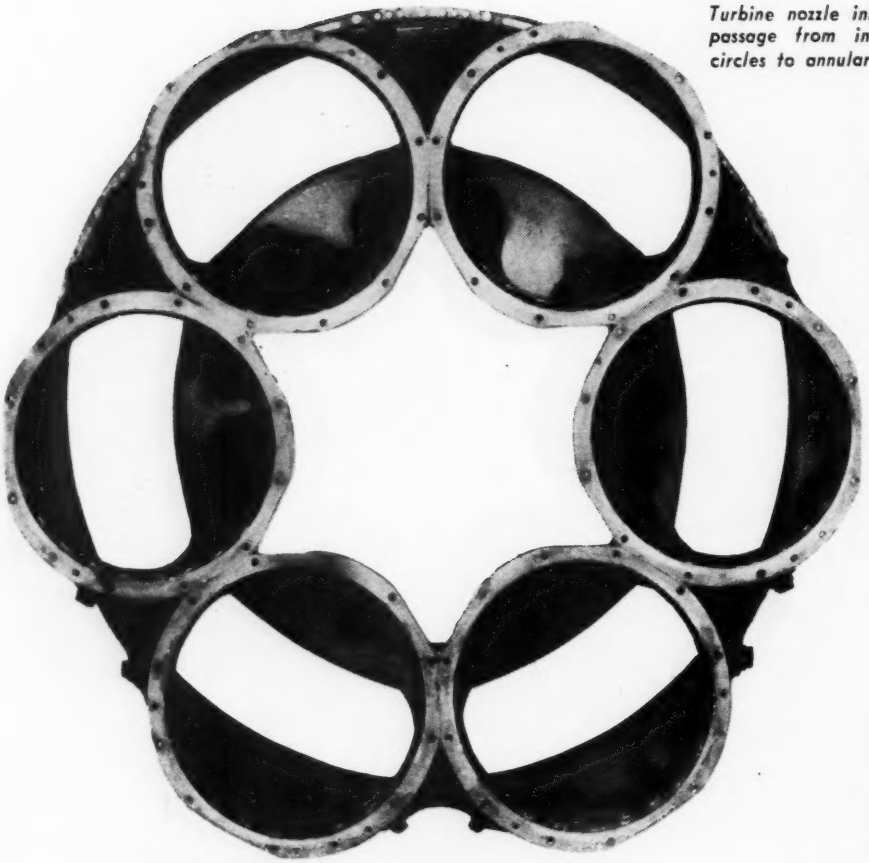
	Stator	*Rotor*
Inlet Guide	32	....
1	61	27
2	61	27
3	59	38
4	61	38
5	61	38
6	71	38
7	71	38
8	57	38

General Data

Wt. (without cowl)	1,669 lb.
Wt. (with cowl)	1,775 lb.
Specific wt.	.85 lb.
Thrust	1,970–1,980 lb.
Pressure ratio	3:1
Fuel consumption	2,720–2,745 lb./hr.
Specific fuel cons.	1.375–1.39
Maximum speed	8,700 rpm.
Idling speed	3,080 rpm.
Idling speed fuel consumption	614 lb./hr.
Length	152 in.
Maximum dia.	34 in.
Frontal area (cowled)	6.4 sq. ft.



Exploded view of combustion chamber showing main components. At left is outer casing, made of mild steel; center is flame tube, showing swirler at front, fuel nozzle, ignition plug connection (on side), and stub pipe assembly; and at right is aluminized steel liner with corrugations to carry cooling air along inside of casing.

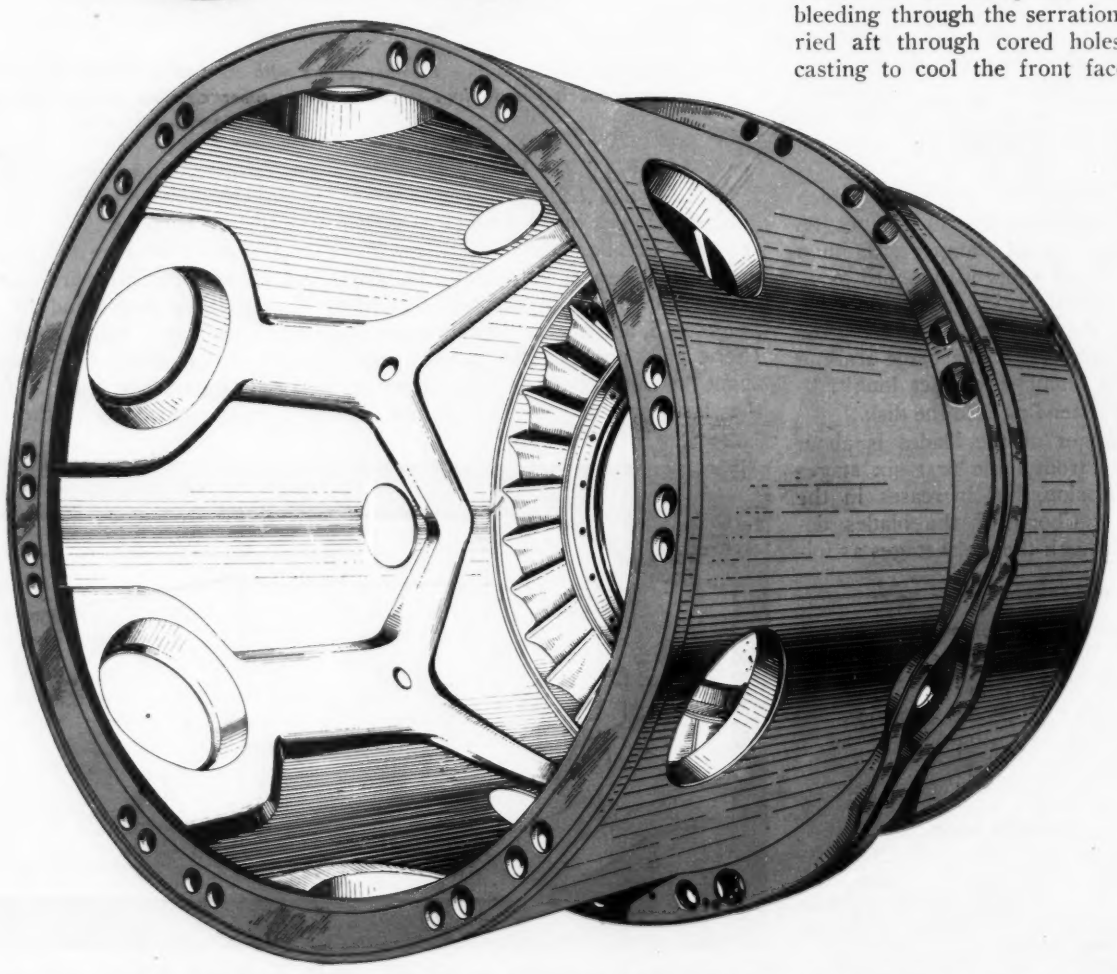


Turbine nozzle inlet ducting which changes air passage from individual combustion chamber circles to annular shape before entering nozzle.

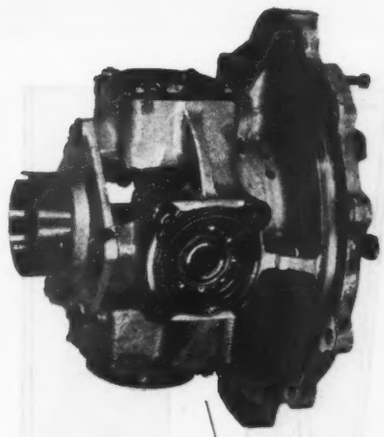
tween rotor and stator blades are .5 and .6 in.

Backbone of the 004 is a complex aluminum casting which, in addition to providing the three engine attaching points, supports the compressor casing —through 25 bolts—the entire combustion chamber assembly, the turbine nozzle, the aft compressor bearing, the two turbine bearings and, through the combustion chamber casing, the entire exhaust system. Moreover, in the base of each of the six ribs supporting the combustion chambers, there are cored passages, five of which carry cooling air, one carrying lube oil. And, while the air passage area remains constant between the compressor and combustion chambers, the main casting changes the shape from annular to circular at the entrance to the chambers.

In the front of the casting, at the tip of the last stator row, is an $18\frac{3}{8}$-in. dia. ring with a serrated inner surface fitting closely to serrations on the aft face of the last compressor disc. Air bleeding through the serrations is carried aft through cored holes in the casting to cool the front face of the

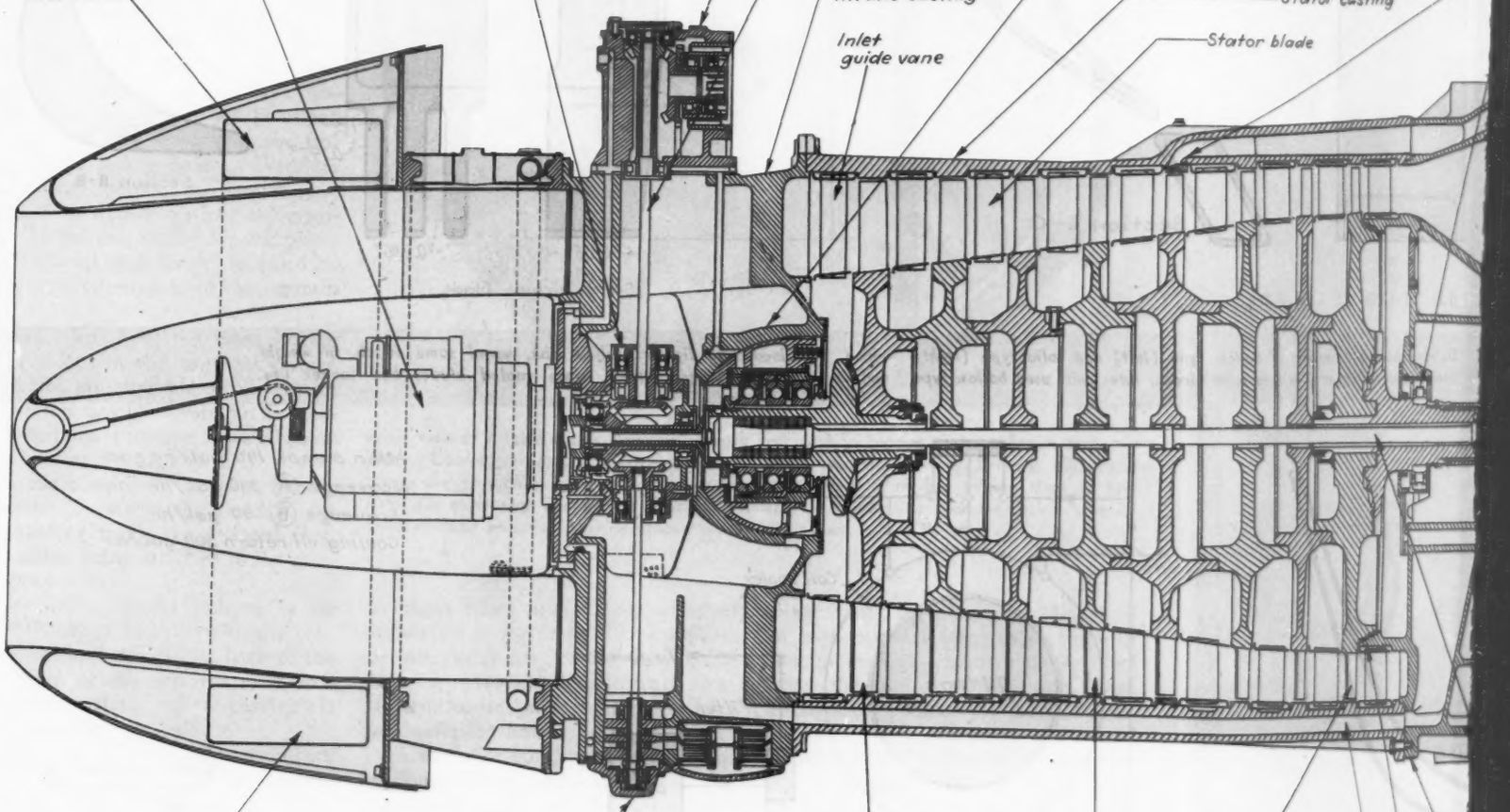


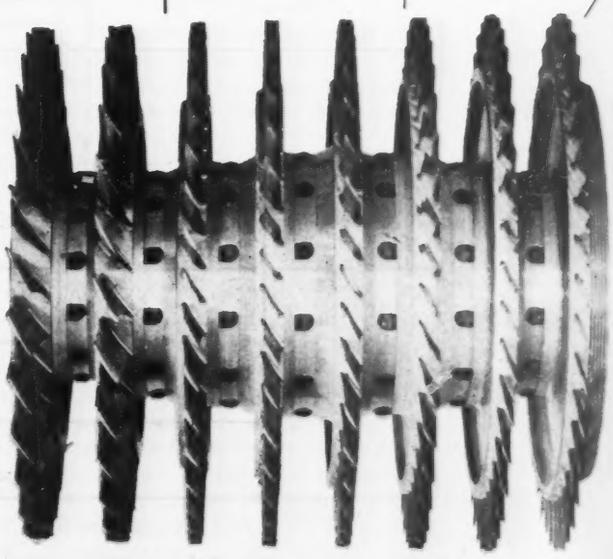
Mild steel double-skinned casing which surrounds combustion chambers. Note holes in front ring which carry cooling air into ducts between the two skins. Access holes lead to combustion chamber ignition plugs and interconnectors. Heavy transverse ring around outside of casing carries tie rod braces into main casting and also serves as attachment for aft engine pickup point.



BEVEL GEAR ASSEMBLY

FRONT COMPRESSOR BEARING

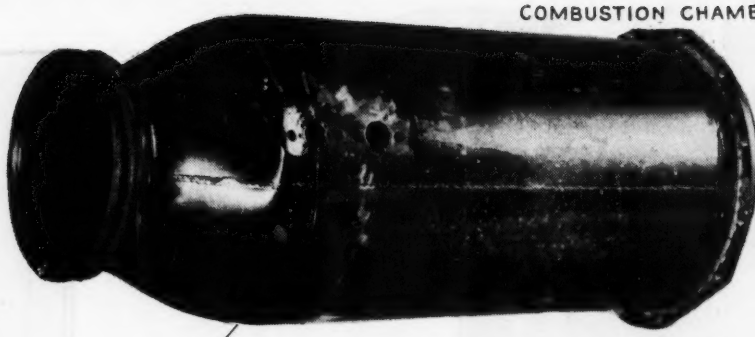


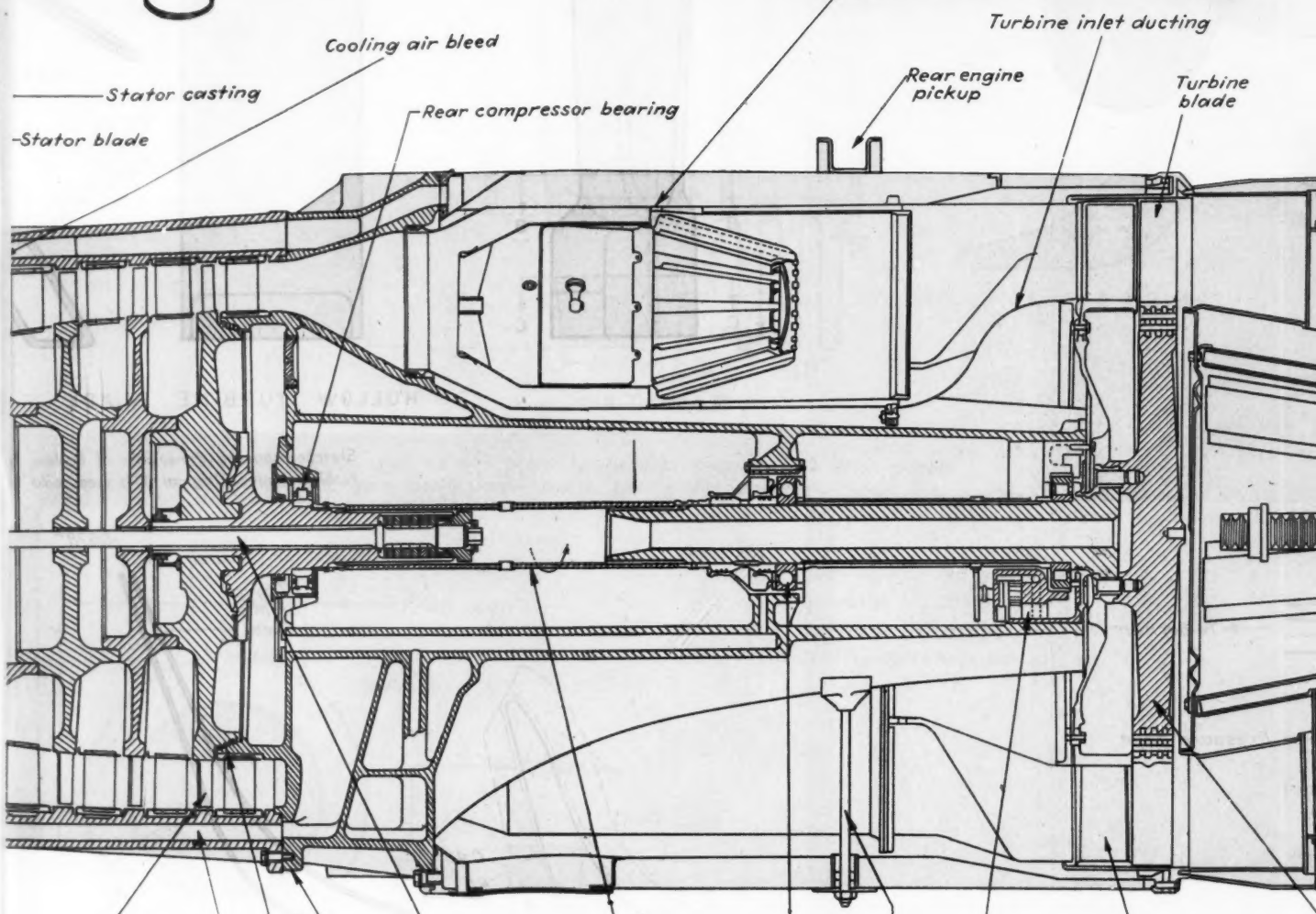


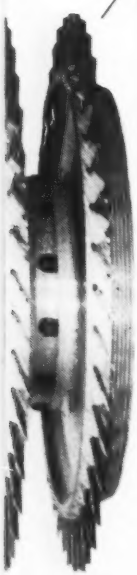
COMPRESSOR

SSOR BEARING

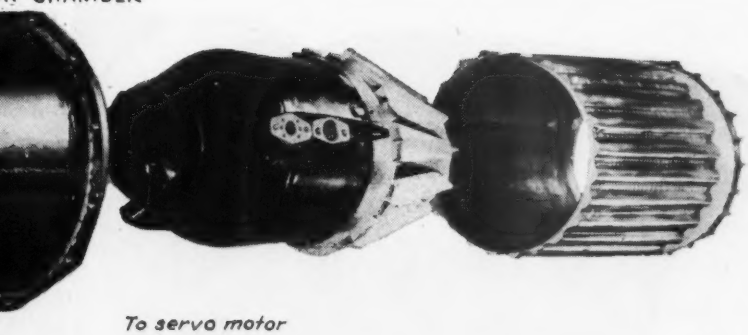
COMBUSTION CHAME

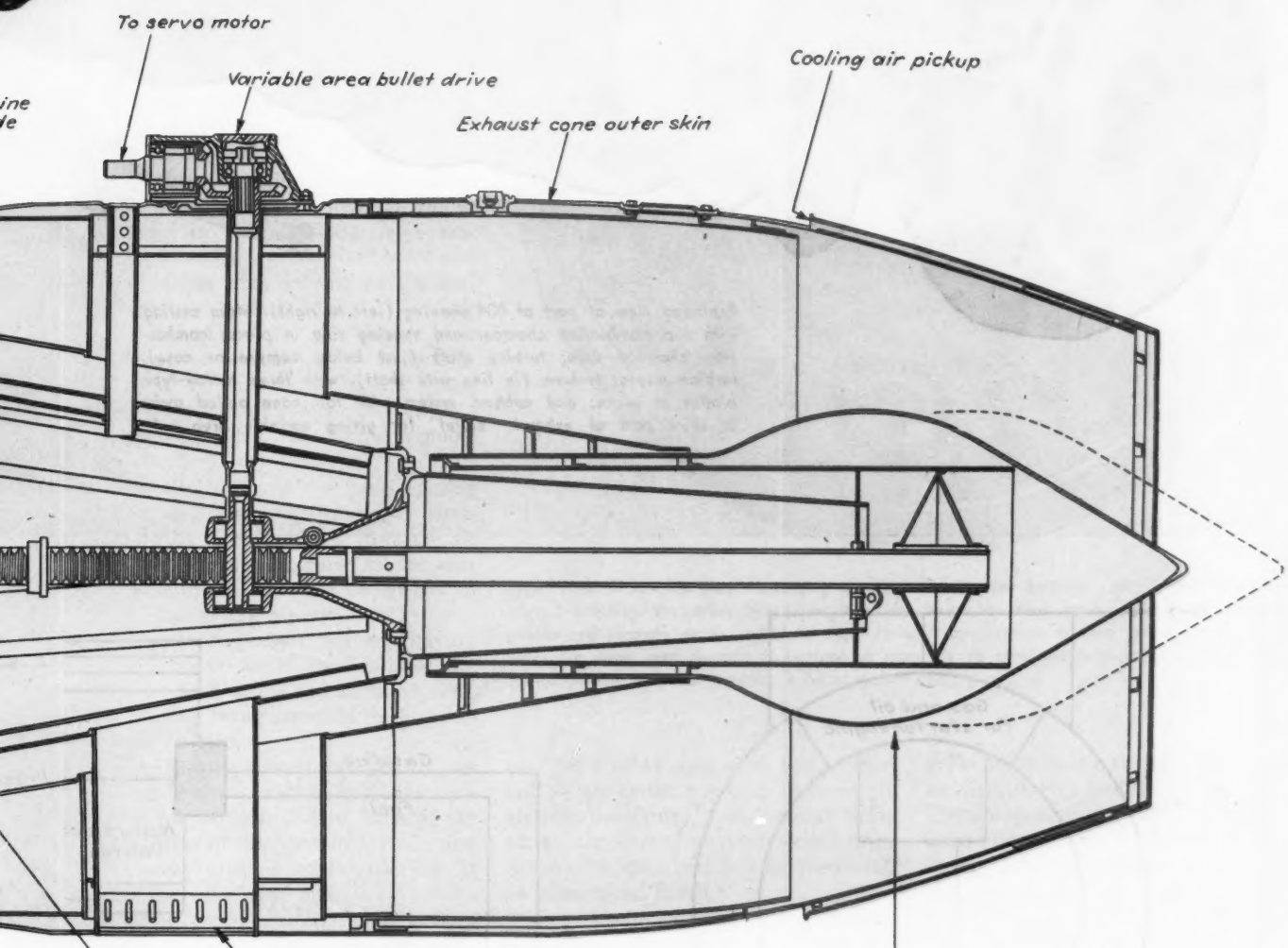


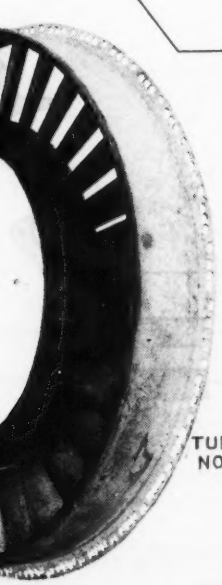




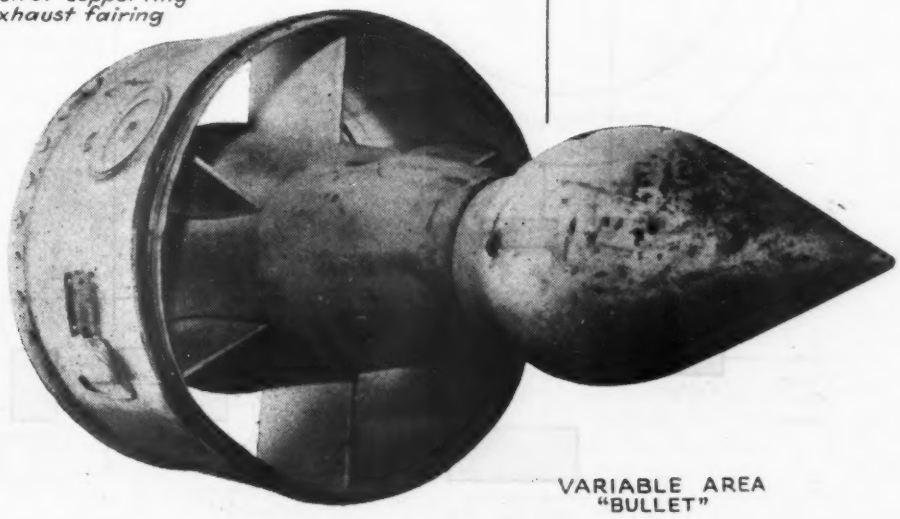
N CHAMBER



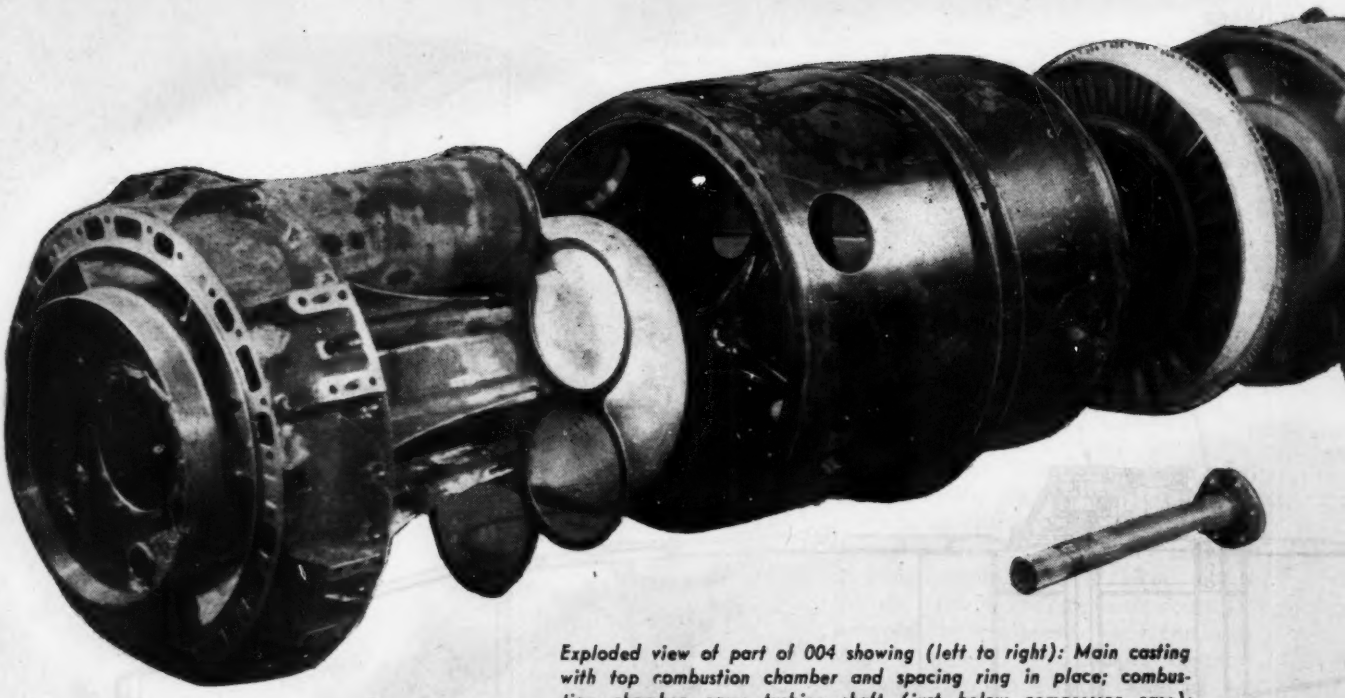




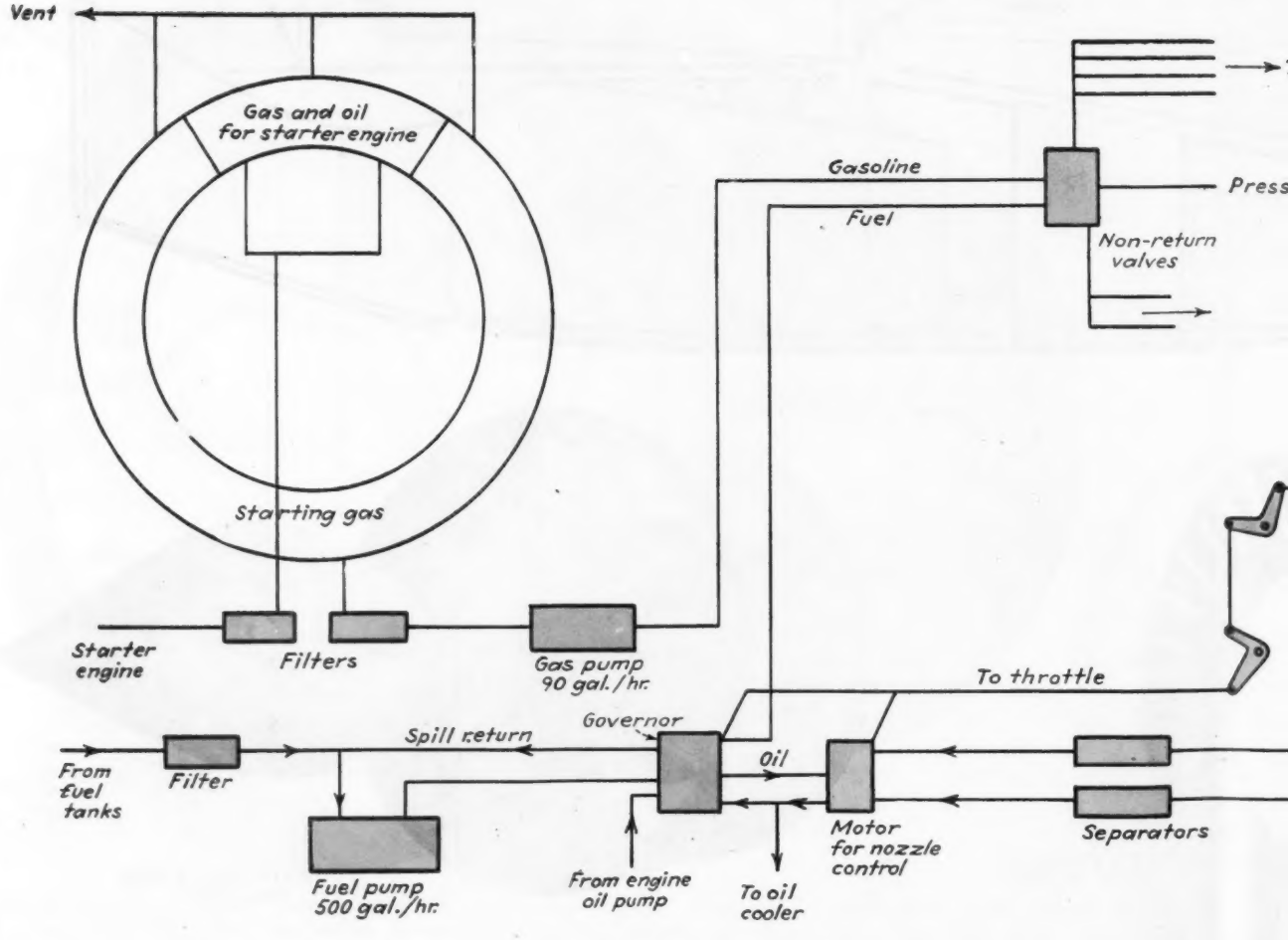
TURBINE NOZZLE



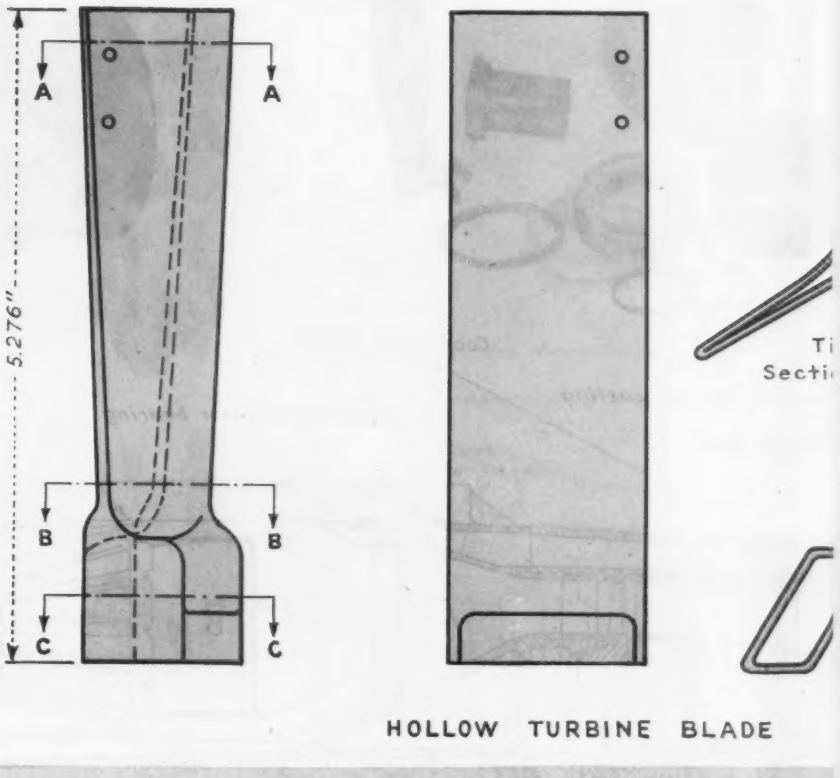
VARIABLE AREA "BULLET"



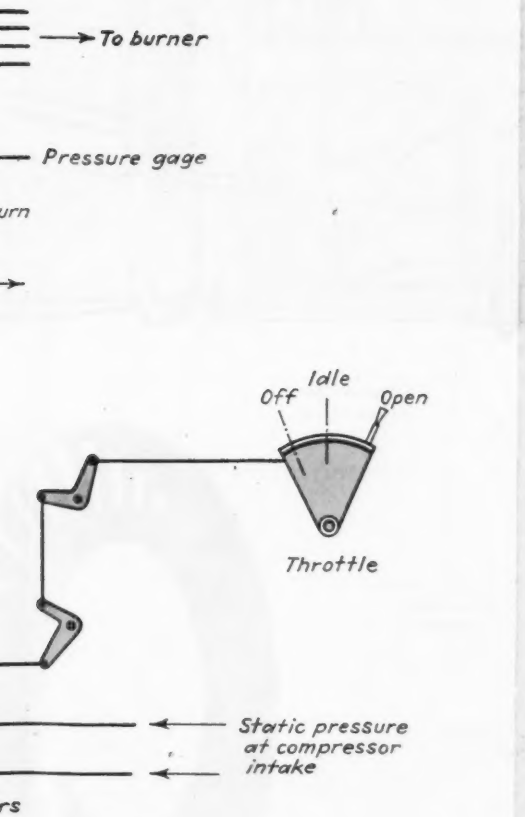
Exploded view of part of 004 showing (left to right): Main casting with top combustion chamber and spacing ring in place; combustion chamber case; turbine shaft (just below compressor case); turbine nozzle; turbine (in line with shaft), with three hollow-type blades in place; and exhaust system with tail cone pulled away to show part of exhaust "bullet" for giving variable area exit.

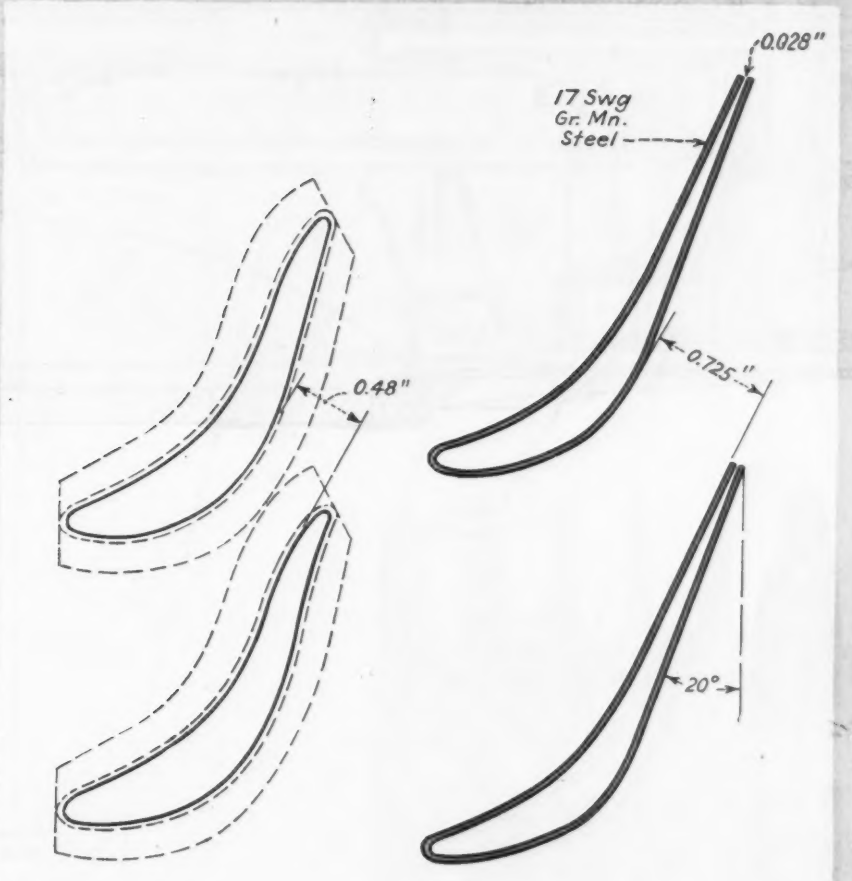


Diagrammatic layout of fuel and exit area control system.

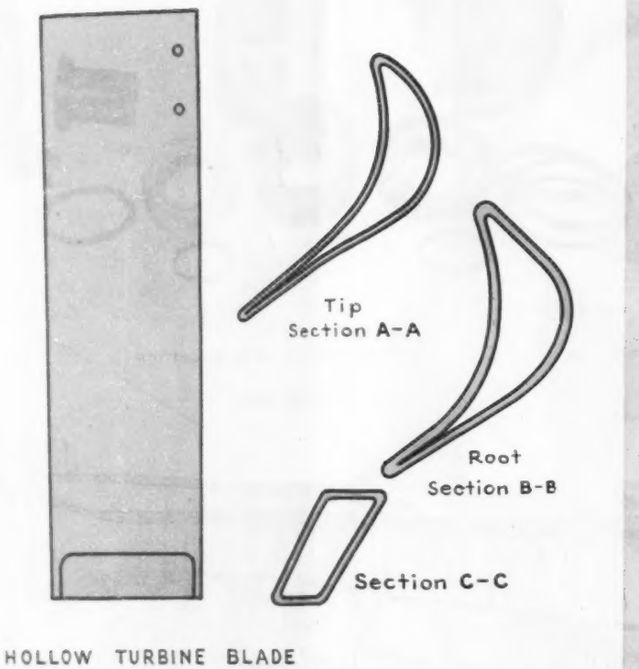


Sketches showing dimensions of hollow ty turbine blades. Original 004s used solid bl

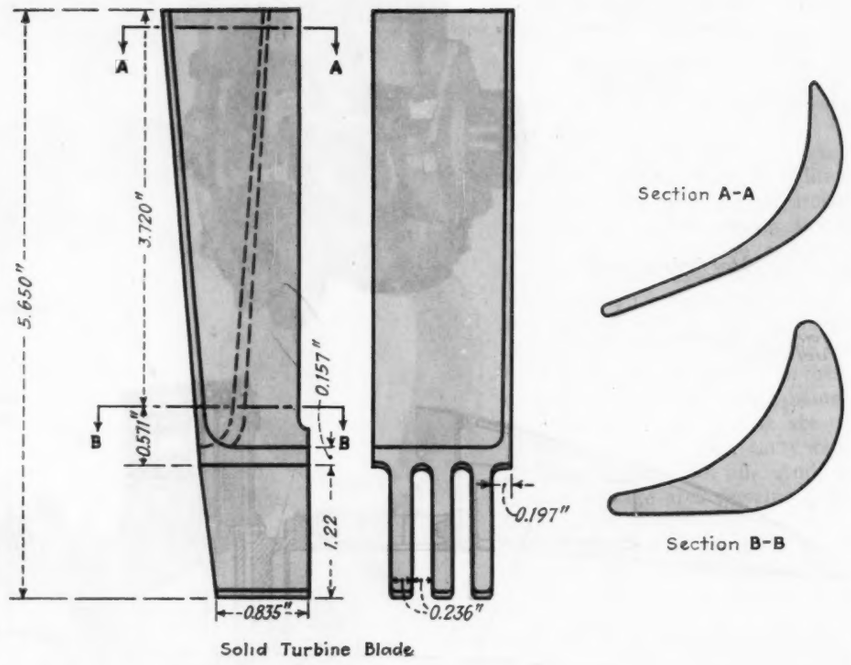




Cross sectional sketches of turbine nozzle roots (left) and tips (right). Engine has 35 nozzles, with nozzle throat area of 84 sq. in.

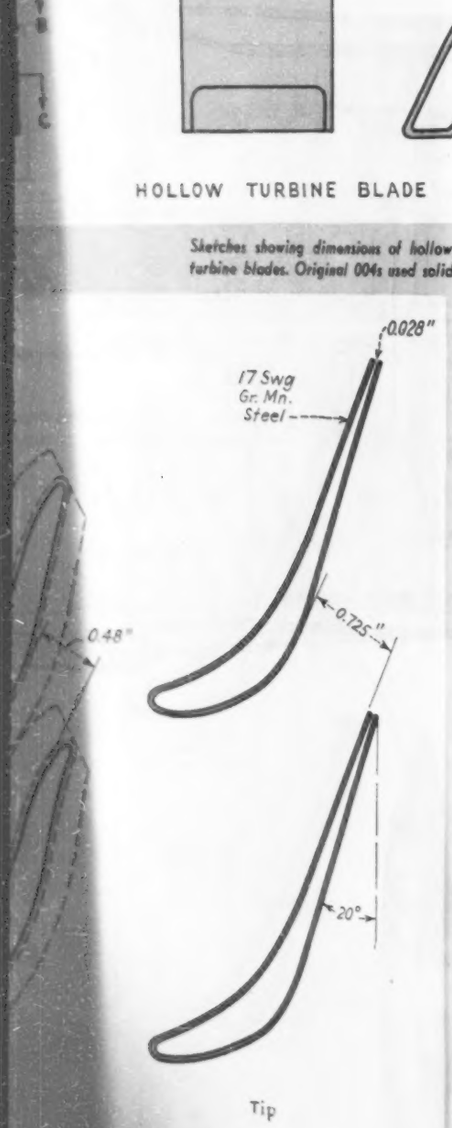


HOLLOW TURBINE BLADE



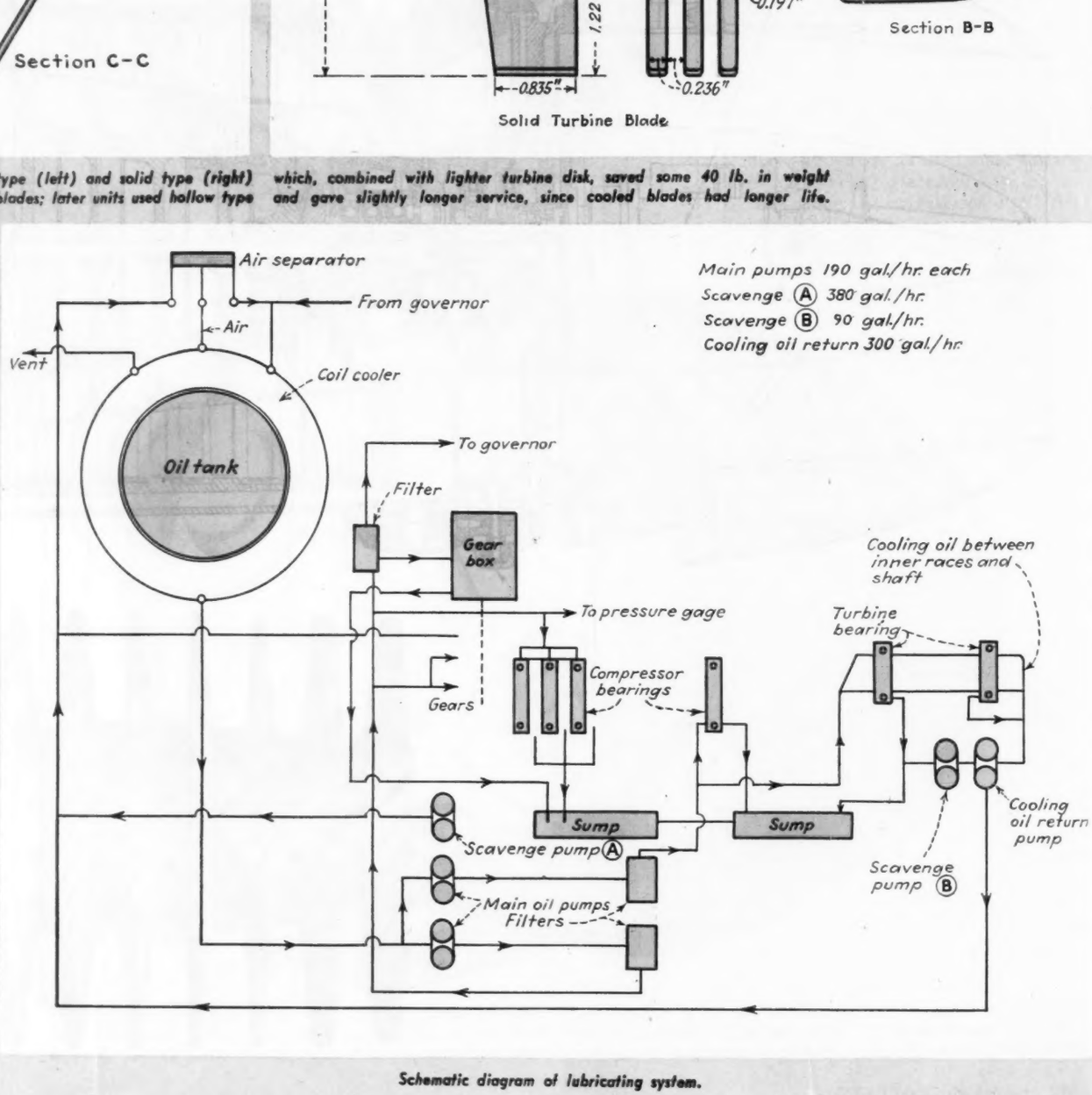
Solid Turbine Blade

Sketches showing dimensions of hollow type (left) and solid type (right) turbine blades. Original 004s used solid blades; later units used hollow type which, combined with lighter turbine disk, saved some 40 lb. in weight and gave slightly longer service, since cooled blades had longer life.



Turbine Nozzles

...sections of turbine nozzle roots (left) and tips (...) 85 nozzles, with nozzle throat area of 84 sq. in.



Schematic diagram of lubricating system.

turbine disk and, on hollow-bladed turbines, to cool the blades themselves.

Just outside and in back of this ring are the fairings which divide the air and direct it into the individual combustion chambers. These fairings, in turn, are surrounded by a 28-in. o.d. ring with 25 bolt holes for attaching the compressor casing. Besides the bolt holes there are 18 openings, six of which carry the air bled off from the compressor on aft for exhaust system cooling, and twelve smaller ones which take cooling air around the combustion chambers.

Around the outside of this ring, extending back to a heavy flange to which the combustion chamber casing bolts, are twelve raised longitudinal ridges arranged in pairs. These have machined faces having four bolt holes and two aligning pins serving as the forward engine pickup points. With six such pickup points, the engine was designed for a wide variety of mountings. In the case of the Me-262 plates with collared nuts were fastened to the two on either side of the topmost unit.

Overall length of the main casting is 37¼ in., with the previously mentioned ribs tapering down from the aft face of the ring structure to the central longitudinal member which has an 8¾-in. dia. at the aft end.

The aft compressor bearing, having 16 rollers, is set in the front of the main casting inside the serrated ring, the housing being attached to the casting by 14 bolts.

The turbine thrust bearing is set inside the main casting, with the centerline of the balls 24⅜ in. back of the front edge of the serrated ring, and the main turbine roller bearing is bolted into the rear end.

Each of the six combustion chambers is built up of three major components having a combined weight of 19 lb. First, there is a mild steel outer casing, of 5¾ in. dia. at the entering end flaring out to 8⅝ in., and having a length of 20⅝ in. The front end has a collar with a rubber sealing ring which is pushed up against the aft face of the main casting to take care of air leakage and to compensate for the difference in casting and combustion chamber expansion.

Fitting inside the front end of this casing is the flame tube, which has two main components—the entry section and stub pipe assembly. The fore part of the entry section flares out somewhat as does the outer casing, and at the front end has a six-blade swirler. This unit is made of 22 gage mild steel with a black enamel coating. The stub pipe assembly is made up of ten flame chutes welded to a ring (which is welded by brackets to the rear end of the flame tube) and to a 4-in. dished baffle plate at the rear. To help direct air into the chutes, ½-in. circular baffle plates are riveted to the forward ring. Material of this unit is mild steel with an aluminized finish.

Front view of turbine nozzle assembly showing rear turbine bearing and diaphragm plates in place. Cooling air enters two holes seen just below bearing, goes up between diaphragm plates and through nozzle roots, then out through openings in trailing edges. Note 36 bolt holes (in outer rear flange) for attaching assembly to combustion chamber casing, also 36 series-of-three holes for carrying exhaust system cooling air.

Third major component of the combustion chamber is an 11-in. long 20-gage aluminized steel liner having a corrugated outer skin which permits cooling air to flow inside the outer casing. This liner fits into the aft end of the casing. The aft ends of the combustion chambers are bolted around flanges to a ring of six rings which fits over the rear end of the main casting.

Ignition interconnectors between chambers are of but 15/32 in. dia., and starting plugs are provided in three of the six chambers. These elements, as are the fuel plugs, are enclosed in streamlined fairings.

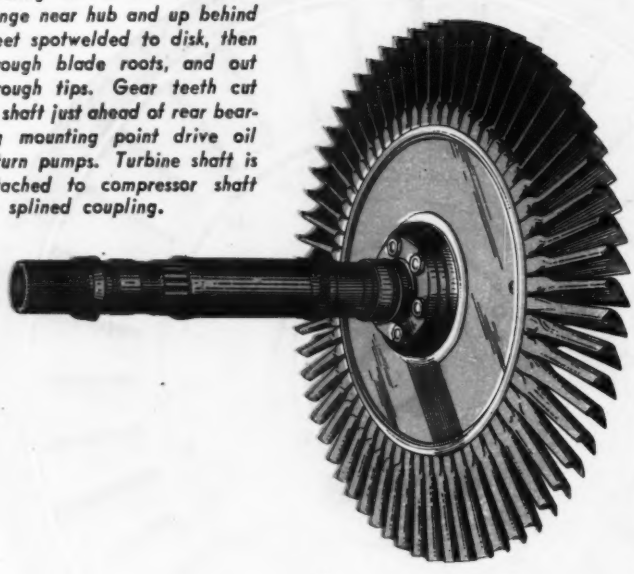
Surrounding the combustion chambers is a 16-gage mild steel double skinned casing having flanges welded at both ends—that at the front end attaching by studs to the main casting; that at the rear attaching to the turbine inlet duct outer flange, the nozzle ring assembly flange, and the exhaust casing flange. Besides the bolt holes in the front flange, there are 24 of similar size, twelve leading to six ducts of 22-gage steel which carry the air bled from the fourth compressor stage through the combustion chamber casing, and twelve directing air around the combustion chambers. These ducts also help stiffen the skin, as it takes the weight of the entire exhaust system.

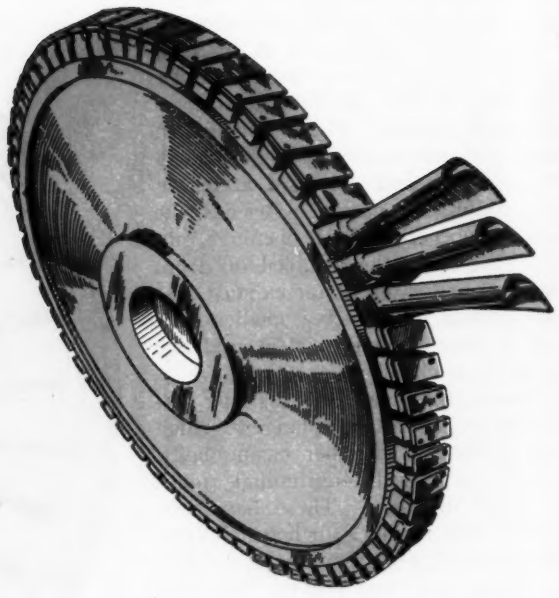
Six large hand holes are cut in the casing just behind the flange. These give access for making minor adjustments to burners and the three ignition plugs.

A little more than halfway aft around the combustion chamber casing is a heavy collar comprised of two channel shaped members, and inside the casing at this ring are six tie rods, connecting it to the main casting. Any one of these six units can serve as the aft engine pickup point; in the case of the Me-262 it is the top one.

Ducting from the combustion chambers to the turbine nozzle changes the air passage from the six circles to annular shape. Attached to the combustion chambers by bolts, this 19-gage aluminized mild steel unit is made in two parts, the rear of which is welded

Hollow blade turbine assembly. Cooling air is forced inside flange near hub and up behind sheet spotwelded to disk, then through blade roots, and out through tips. Gear teeth cut on shaft just ahead of rear bearing mounting point drive oil return pumps. Turbine shaft is attached to compressor shaft by splined coupling.





Detail sketch of turbine disk showing method of attaching hollow blades. Groove in disk stub is filled with special high temperature silver-base brazing flux, blade is then pinned in place, and entire unit heated. Two small holes on ends of disk stubs direct cooling air through blade roots.

to a heavy flange. Studded to this flange from the inner shroud ring of the turbine nozzle assembly are two mild steel diaphragm plates. These, in turn, are studded to the rear end of the main casting, and so support the inlet ducting and turbine nozzle ring. On the rear of the outer turbine inlet ducting a light flange mates with a flange on the rear of the combustion chamber casing. Thus the turbine inlet ducting, to which the combustion chambers are attached, is supported partly by the main casting, partly by the diaphragms, and partly by the skin.

Maintenance crews really take a beating as the result of the final design, for it is a major operation to get at the combustion chambers. First, the variable-area nozzle operating shaft must be removed so that the complete exhaust system assembly can be taken off. Then, unless special equipment is available, the engine must be placed upright on the turbine disk and burner pipes and ignition leads disconnected from the combustion chambers. Then the compressor casing-main casting joint can be broken and the whole front end of the engine lifted off. Next the rear compressor bearing assembly, torque tube, and locking ring can be removed and the main casting assembly removed—when the nut on the front end of the turbine shaft is unscrewed. The rear diaphragm plates can then be removed and the turbine inlet ducting and combustion chamber assembly lifted off. Then the front diaphragm plate is removed and the turbine inlet ducting, with the combustion chamber assembly, lifted out of the casing. At this point, as one sweating engineer who did the job declared, "Now, Bub, y'can take out the individual combustion chambers."

An unusual feature of the 004's design is the use of hollow turbine nozzle blades through which cooling air is fed from the compressor via the main casting and supporting diaphragm plates. The two-part outer nozzle shroud ring is made of mild steel and both parts are welded to a ring that is joggled and flanged to mate with flanges through 36 bolts on the inlet ducting and the aft flange of the combustion chamber casing. In addition to the bolt holes the flange has 36 sets of three holes for cooling air passage.

The 35 nozzles are made of austenitic sheet steel, .045 in. thick, bent to shape around a 1/16-in. radius to form the leading edge. Between the sheets at the trailing edge are spotwelded four wedge shaped spacers, 1 in. long and tapering from $\frac{1}{8}$ to .020 in., leaving a .020-in. gap down the trailing edge through which the cooling air escapes.

In assembly, the blade tips are closed, pushed through slots welded to the outer shroud ring, and the roots are pushed through slots in the inner shroud ring and spotwelded in place on the inner surface of the ring.

To this ring, in turn, is welded a heavy, mild steel flange and second flanged ring, the two flanges picking up with the diaphragm plates which support the assembly from the rear of the main casting.

Two types of 61-blade turbines are used. Originally both blades and disks were solid, later hollow blades and lighter disks were introduced at a saving of approximately 40 lb.

The solid disks were of hardened chrome steel, taking stresses of about 15 tons at maximum rpm. Cooling is effected by spilling air bled back through the main casting against the disk face then up over the blade roots and out between the blades.

The 12¼-oz. solid blades are forged from an austenitic steel containing 30% nickel, 14% chrome, 1.75% titanium, and .12% carbon, corresponding closely to "Tinidur," a Krupp alloy known before the war, and are attached by three machined lugs drilled to take two 11-mm. rivets each. Maximum centrifugal blade stresses have been estimated at 18,000 psi., and gas bending stresses at 2-4,000 psi. Study of the solid blades indicates that the roots didn't get much above 450 deg. C., due to the cooling air flow up from the disk, but near the center it appears the temperatures got up to about 750 deg. C. This applies to service models, not those previously mentioned as having given the longer flight and test-stand life.

Disks for hollow blade turbines are of lighter material than the solid types and have attached, across the front face, a thin sheet flared out near the center. This picks up the cooling air and, via ridges on the disk, whirls it out toward the blade roots where it goes through two small holes drilled in the disk rim up through the blade and out the tip.

Made of the same material as the solid blades, the hollow type are formed by deep drawing a disc through a total of 15 operations. In assembling the turbine, the blade roots are fitted over

grooved stubs on the disk rim. Two small holes on each side take locating pins to hold the blades in place during assembly, but they take no stresses.

With a silver-base flux in the grooves, the entire unit is put in an oven at 6-800 deg. C., warmed for 20 min., then heated to about 1,050 deg. C. in 40 min., then cooled in still air at room temperature before hardening in a gas or air oven.

Later production units have two rivets in the blade trailing edges near the tips, a modification made necessary by cracking caused by vibration.

The turbine is attached by six studs to a short shaft carried on two bearings housed in the main casting. The front bearing is a single-race ball thrust, the rear a single-race roller type, and both are cooled by oil only. Connection of the turbine and compressor is via a heavy, internally splined coupling.

The exhaust cone is made up of aluminized mild steel, and consists of two major components; outer and inner fairings. The outer fairing is double skinned, with cooling air bled from the compressor flowing between the skins to within 15¾ in. of the exit where the inner skin ends. Outside the other skin from there to the end is another skin, flared at the leading edge to scoop in cooling air. It is attached by spot welded corrugations.

Attached to the outer fairing by six faired struts is the inner fairing, tapering from 19½ in. at the turbine end to 9¾. This unit houses a rack gear—driven by a shaft entering through one of the struts—which moves a "bullet" extending from its aft end. Actuating this bullet over its maximum travel of approximately 7⅜ in. varies the exit area between 20 and 25%. It is set in retracted position for starting to give greater area and help prevent overheating, then moved aft to decrease the area and give greater velocity for takeoff and flying. The movement is accomplished by a gear-type servo motor set near the accessory housing and connected by a long torque tube to gears set on the exhaust housing over one of the struts leading into the previously-mentioned rack gear.

Originally the unit was supposed to operate automatically over small ranges at extremely high speeds and altitudes to give maximum efficiency, but on some engines examined the necessary lines had been blanked off. The two-position operation is obtained through a mechanical linkage with the throttle so that the bullet moves aft at between 7,000 and 7,500 rpm.

Since the necessary cooling system played a very important part in both the design and construction of the 004, it is felt best to note it briefly as a separate part of the study. It consists of three major stages, as follows:

1. Air bled off after the 4th compression stage.
2. Air taken off just after the last compression stage.
3. Air bled off between the compressor and combustion chambers.

In Stage 1 the air is picked up by the ring after the 4th compressor row and is directed into six cored passages in the stator casting, then at the combustion chamber casing it is divided so that some of the air goes through six ducts in the combustion chamber casing skin, some goes inside the casing and around the chambers themselves. That which goes into the ducts continues aft and, through small holes in the flanges, between the double skin of the exhaust cone outer fairing. Majority of the air goes straight on aft to the end of the inner skin, but some is taken through the six struts connecting the inner fairing into that unit to cool the rack gear and bullet.

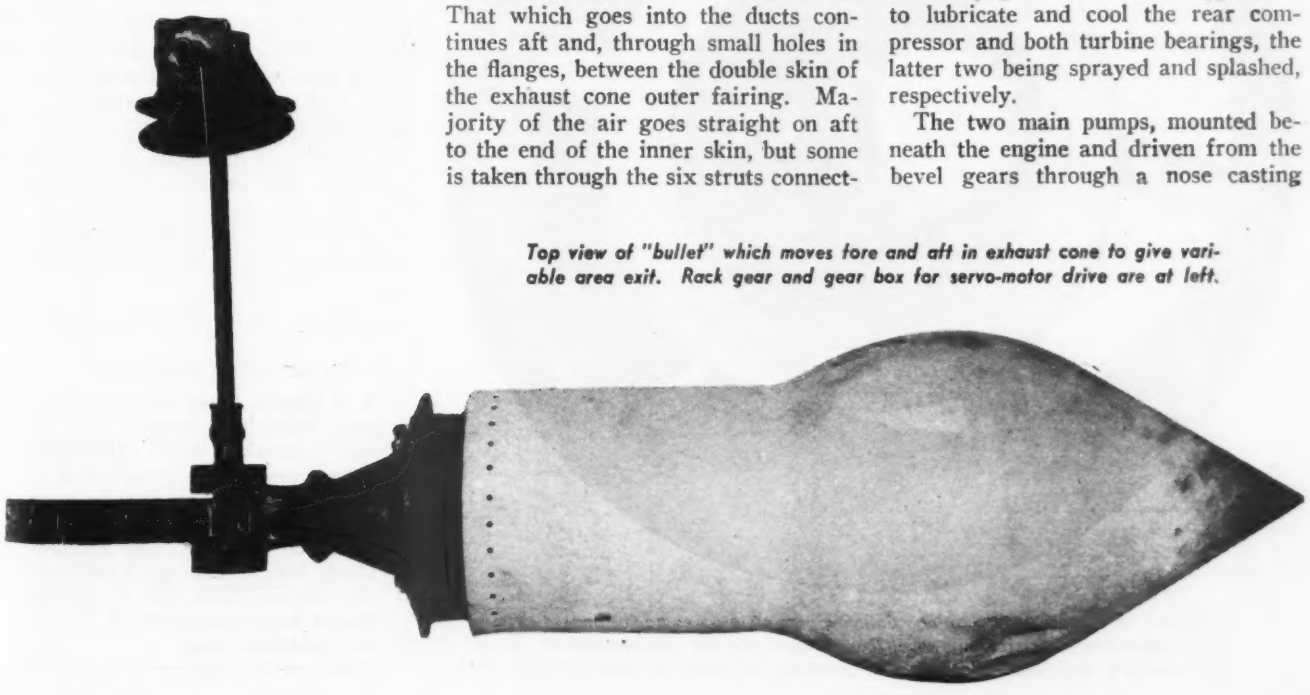
In Stage 2 the air goes through the serrations between the compressor and the main casting, into two of the six cored passages in the casting back to the turbine. Here, on the original engines, it was spilled against the face of the turbine disk and moved out to escape between the turbine blades. On engines with hollow blades, however, the air is ducted across the space between the two diaphragm plates supporting the turbine nozzles, then inside the sheet attached to the turbine disc where it is picked up by ridges and forced up through the turbine blade roots out through the blade tips.

Stage 3 cooling air, bled off between the compressor and combustion chambers, is ducted through three passages in the main casting to the space between the turbine nozzle-supporting diaphragms, then up through the turbine nozzle vanes and into the slipstream through the trailing edges of the vanes.

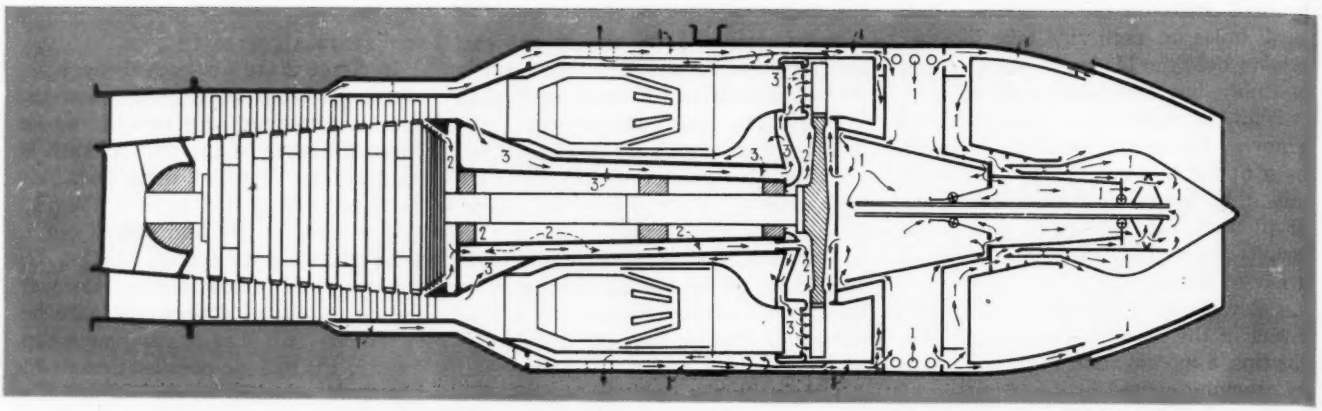
It is estimated that Stages 1 and 3 take approximately 3% each of the total air movement, and that Stage 2 probably takes at least half as much; thus better than 7% of the available flow is taken off because of a lack of higher heat-resistant alloys. Additional performance penalties are evident in the fact that ducting is necessary, complicating both the weight and production pictures.

Air is not the only cooling medium, for the lubricating system too is employed. In this system, two gear pumps circulate lube oil to the front compressor bearing assembly, the accessory-drive bevel gears, and the accessory gears. Another supplies oil to lubricate and cool the rear compressor and both turbine bearings, the latter two being sprayed and splashed, respectively.

The two main pumps, mounted beneath the engine and driven from the bevel gears through a nose casting



Top view of "bullet" which moves fore and aft in exhaust cone to give variable area exit. Rack gear and gear box for servo-motor drive are at left.



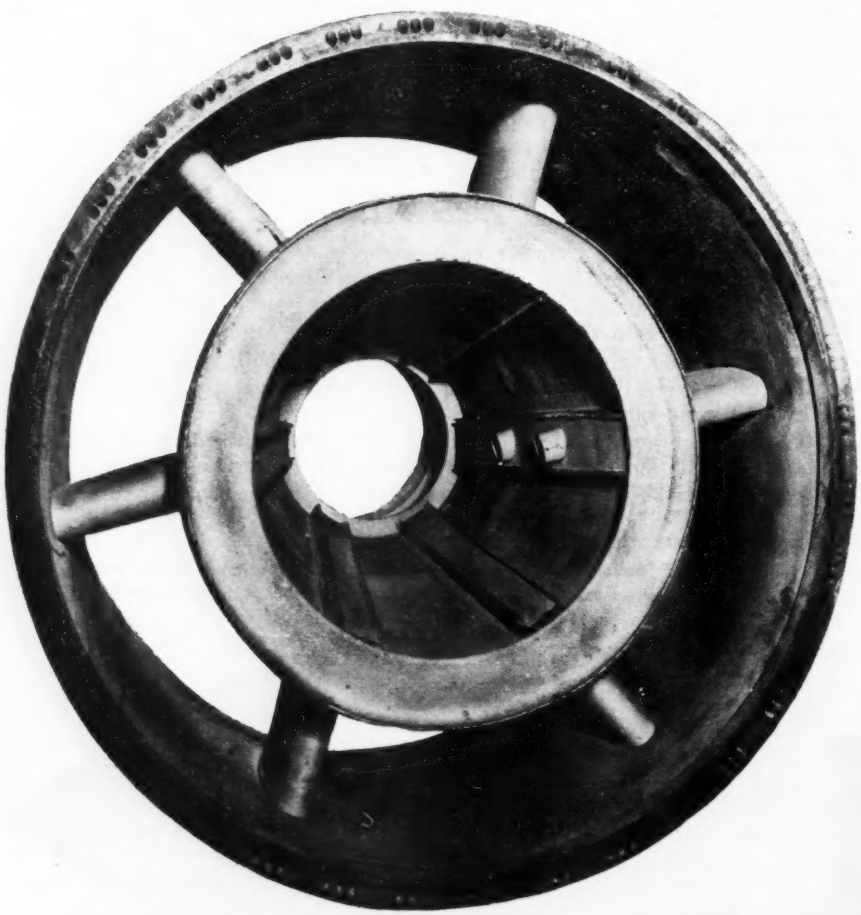
Schematic diagram of cooling system, which takes well over 7% of total air intake. Stage 1 air, bled off after fourth compression stage, cools exhaust system. Stage 2 cooling air taken through serrations on last compressor disk, is directed through main casting to cool turbine disk and, on units with hollow turbine blades, through the blades themselves. Stage 2 air, taken off between compressor and combustion chambers, is carried through main casting to cool turbine nozzles. Note course of cooling air in and out of "bullet."

strut, deliver 190 gal./hr. each. The two-part scavenge unit is built into the turbine bearing housing and is driven by a gear cut into the sleeve which serves to return oil to the cooler. In level flight, one part of the unit, a 300-gal./hr. pump, returns oil through one of the cored passages in the main casting, then through a passage in the stator casting to the pump in the bottom of the intake casting. In climbs, the other part, a 90-gal./hr. gear pump, picks up the oil and feeds it into a common return line to the air-oil separator. Oil is returned from the main pump to the separator by a 300-gal./hr. pump driven by the same shaft as the delivery pumps.

Two types of fuel are used on the 004; gasoline for starting, and J-2 brown coal "crud" for running. The gasoline is carried in the lower part of the annular tank set in the nose cowling, and is automatically cut off after ignition at about 3,000 rpm. This is fed by an electrically driven pump delivering 90 gal./hr. at 28 psi. Near the end of the war it was found that centrifugal crude oil was also used as operating fuel.

The main single-stage electrically-driven gear type pump has a maximum delivery of 500 gal./hr. at 1,000 psi., at 3,000 rpm.

Most interesting of the accessories is the all-speed governor, a 17-lb. unit consisting basically of a centrifugal governor, oil pump and spill and throttle valves. In operation, oil goes through a passage to the pilot piston and is distributed to outer faces of either the spill or follow-up piston, depending on movement of the flyweights. Both the pistons move at the same time, adjusting the fuel spill to counteract changes in engine speed. The distance between the spill and follow-up pistons varies according to the flow of oil through the passages so that the spill piston action is a step-by-step operation controlled by the follow-up which returns to normal position after each step. A throttle valve is linked with the governor cam so that when the throttle is advanced the fuel flow increases and response is immediate. The governor then takes over and adjusts the engine speed to a predetermined value set by the position of the cam.



Front end of exhaust cone showing cooling air holes in outer flange and faired struts supporting inner structure which houses rack gear for moving "bullet" to give variable area exit. Note cooling air inlets at root of strut at right.

ACKNOWLEDGEMENT

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ANALYZING THE ASPECTS OF FUTURE FLIGHT

PART I

By C. E. PAPPAS, *Chief of Aerodynamics, and*
M. G. HARRISON, *Aerodynamics Mathematics Consultant, Republic Aviation Corp.*

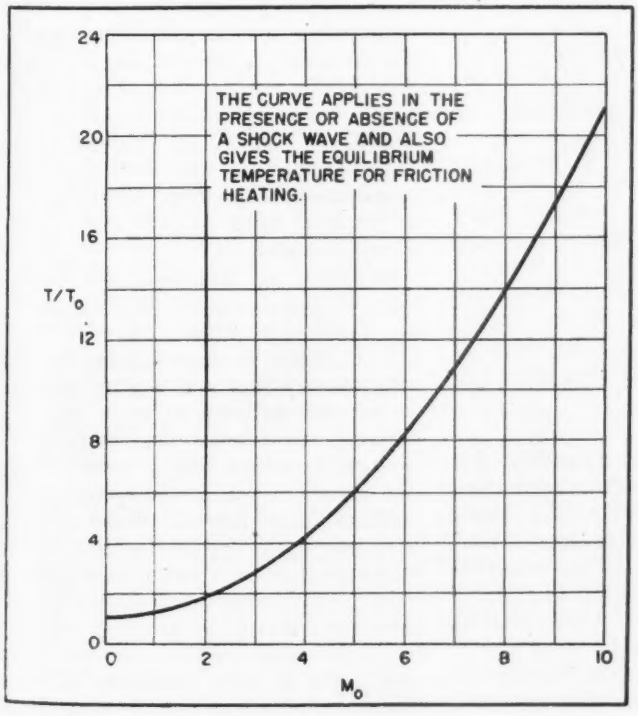
Pacing the trend toward still faster speed—using present-day plane designs at already-attained flight levels—are the more-than-just-difficult hurdles of flow instability, surface heating, and horsepower required. Though pointing the way out, extreme high altitude operation will bring new and knotty problems — which this searching analysis aims to resolve . . . First of a series on tomorow's aeronautics.

EVERY INDICATION points to the need for high altitude flight, since the tendency for flying at higher and higher speeds results in excessive resistance, surface heating due to frictional effects in the boundary layer, and the indeterminate character of flow at Mach numbers between 0.85 and 1.2. These effects arise because at conventional altitudes flight is still made in an atmosphere. Future airplanes will probably fly at very high altitudes—60 to 100 mi. above the earth—since cooling of the external surfaces will otherwise become of paramount importance when flying in an atmosphere.

High-altitude high-speed flight will depend almost entirely on the development of power units and fuels for affording enormous power. Power derived from atomic energy should be given first priority in the development of supersonic aircraft, since with this form of energy, power units could probably be made quite small in comparison to existing power plants.

In this discussion, heating effects resulting from flight in an atmosphere are presented in the form of curves. It is proved that when the flow traverses a normal shock, the temperature at the stagnation point of a body is the same as though a stream of air were brought to rest adiabatically. Also considered are hp. required for extreme high speed flight, temperature of the body when immersed in an ambient field of 1,700 deg. F., and Schlichting's analysis of supersonic flow with special reference to downwash patterns.

New problems of high altitude flight are presented—energy required for flight, ionization of air, meteoric dust, and electrification of the atmosphere. However, heating effects resulting from recombination of ions on the surface of the body, also the heat



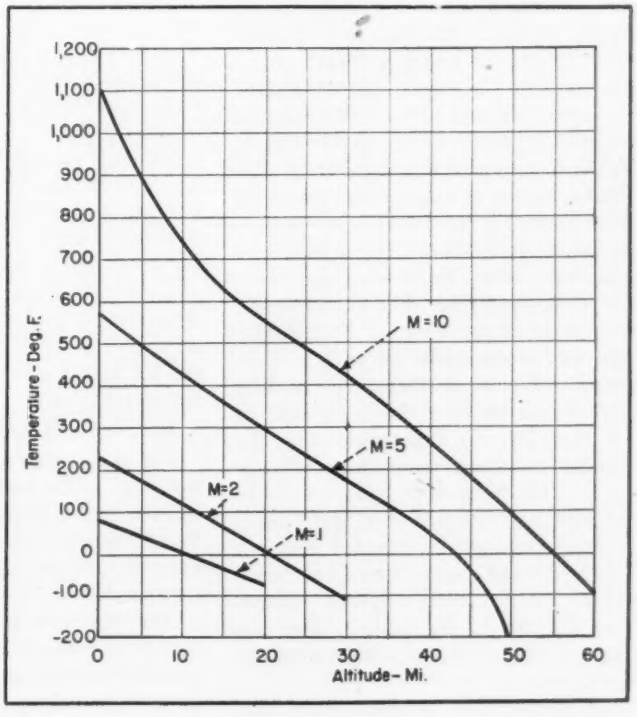


Fig. 1 (left): Temperature rise ratio (from free stream temperature to stagnation point) vs. initial Mach number. Fig. 2 (right): Equilibrium temperature of body radiating heat (to absolute zero) supplied from boundary layer friction, with heat considered to be uniformly distributed over body.

equivalent of the electrical energy storage because of body electrification at high altitudes are both shown to be negligible.

The projectile flight theory and proposed trajectories for distance to be traversed are derived, and the flight orbit is determined so that the required energy is minimum.

Atmospheric conditions at extremely high altitudes are also included in chart form—pressure, density, and temperature vs. altitude up to 180 mi.

Modern high speed planes have already attained a Mach number of 0.75 in level flight. At a number between .85 and 1.2, the plane will, in all probability, experience severe buffeting resulting from unsteady airflow conditions. And of even greater importance than compressibility effects will be difficulties of achieving stability because of unsteady airflow—as appears from the Guidonia wind tunnel tests.

Since unsteady flows prevail from .85 to 1.2, it is best that the plane fly through this unsteady region with large accelerations so that the steady state laws of motion do not act because of the small time element. Another method of approach would be to restrict the plane to Mach numbers of .75 to .80 in flight until altitudes are reached where the atmosphere is so rarefied that the effects of shock waves become negligible.

If one were to fly at altitudes where the atmosphere is still quite appreciable, several difficult design problems would present themselves. Horsepowers required to fly at Mach numbers of 2 or 3 would be prohibitive for a conventional plane and would be in the neighborhood of 40,000 hp. at 50,000 ft. for a Mach number of 2.0.

Also, to fly at supersonic speeds in an atmosphere, special airfoils such as the Riabouschinsky or Busemann type —having very little $C_{L\max.}$—would have to be employed. The airfoil would have to be very sharp at the leading edge and necessarily very thin, thus posing difficult problems of landing gear retraction into the wing and of fuel capacity. In supersonic flow the moment resulting from drag will be large. The wing will have to be so designed and located that the Mach wing tip cone when extended does not include the tail surfaces so as to avoid serious interference effects — somewhat difficult to accomplish since the angle of this cone is a function of the Mach number.

Another serious problem associated with extremely high speed flight in an atmosphere, will be the heating effects of the body surface because of friction of the air particles moving over the surface. Cooling of the external surfaces will present an almost insurmountable problem at high Mach numbers and it would, therefore, appear logical to fly at extremely high altitudes where the density of the atmosphere tends toward zero. For such altitudes, the problems of optimum fuselage and airfoil shapes, cooling of external surfaces, and other related factors, will no longer exist. But many other problems will be presented —stability and control, ionization of air (Kennelly-Heaviside ionized layer), meteoric dust, and electrification of the atmosphere. These factors will be discussed after the problems associated with flying in an atmosphere have been considered.

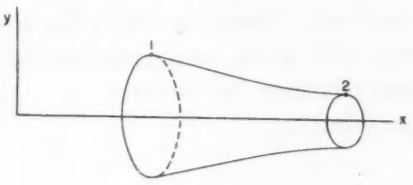


Fig. 3. Diagrammatic representation of soap film with body of revolution in form of catenoid.

Heating

First problem to be treated is that of heating. The temperature of the airstream in the vicinity of the body is raised because the air is compressed and because of the friction in the boundary layer. Both effects are most pronounced near the nose of the body, with compression heating being most localized.

When a stream of air is brought to rest either adiabatically or after traversing a shock wave, it will be found that the absolute temperature has been increased by a certain ratio from the free-stream temperature. This ratio depends on the initial Mach number only and in either case is given by the formula (see Appendix, page 134, for derivation):

$$T/T_o = 1 + 0.2\,M^2_o$$

Fig. 1 is a curve showing this relationship. The temperatures are absolute so that rather high values result. For example, with free-stream temperature = 40 deg. F., the temperature at M = 10 is 10,170 deg. F.

Von Karman-Tsien[1] have derived equations which can be used for a qualitative estimate of the heating effect of boundary layer friction. According to their analysis, the temperature of a body heated by friction will be given by the same equation as compression heating, as given above. However, at high altitudes, where the air density is very low it is expected that the flow of heat to the body will be so low that radiation will be able to dissipate the heat fast enough to keep the temperature down.

To test this conjecture, the heat flow to a body 30 ft. long was calculated using the equations of Ref. I. The calculations were carried out at a number of body temperatures, altitudes, and Mach numbers. Assuming that this heat was distributed evenly over the body surface and radiated according to the law for black bodies, it is possible to determine an equilibrium temperature at which the heat flow to the body, by conduction and convection, is equal to the heat radiated. It was assumed in these calculations that no radiant energy was received by the body and no account was taken of the effect of pressure gradients. Also, since the rate of friction heating at the forward end of a body is very high and tends to produce the same temperature as compression heating, it is thought that compression heating may be properly ignored.

The results of this calculation are presented in Fig. 2, in which it is seen that altitudes above 50 mi. may be required for extreme Mach numbers if the temperature is to remain tolerably low. It must be emphasized that these results only indicate the orders of magnitude. However, it is seen that the effect of radiation reduces the temperature considerably. For example, for Mach number = 10, the temperature in the absence of radiation would be of the order of 5,000 to 10,000 deg. F. at all altitudes (see Fig. 1), whereas with radiation, the temperature ranges from 1,100 deg. F. at sea level down to −60 deg. F. at 60-mi. altitude.

Bateman[2] has discussed the instability of a compressible flow by analogy with soap films (minimal surfaces). While it may appear that a delicate soap film and a plane diving at terminal velocity make a strange contrast, nevertheless, the comparison is quite arresting, and it seems that the equation which determines the speed of the air flowing around a wing is similar to the equation which determines the shape of a soap film stretched over a wire framework. (If the pressure and density of air were related by the formula used by von Karman and Tsien in their treatment of the Hodograph Method, then the soap film equation would have the same form as that for the airflow). It is therefore reasonable to expect to find ways

[1] All references are collated at end of article, page 134.

in which a soap film behaves, which are similar to the behavior of a compressible airflow.

Soap films have been the subject of much experimentation. We can, therefore, describe some soap film phenomena whose extension to flows would be rather interesting.

Consider a soap film which is stretched between two rings (Fig. 3). If the rings are not too far apart, the film has a definite shape depending on the position of the rings. If, however, the rings are moved apart, a point is reached at which the film suddenly necks down in the middle and pulls apart into two plane areas—one within each ring. If any such similar change were to occur in a compressible flow —as when deflecting an aileron—the effects might be a sudden loss of control with small possibility of regaining control, just as there is small possibility of re-forming the original shape of the soap film.

Other examples can be given in which several films can be formed on the same wire framework—a particular film depending on how it was formed. The analogous phenomenon in airflow would be that of having several flows with the same airplane configuration, depending only on how the airplane was flown previous to the time it came into the configuration. If two flows corresponding to the same configuration could readily interchange, severe changes of airload might occur and if the dynamic properties of the airplane were not just right, buffeting and vibration could be expected.*

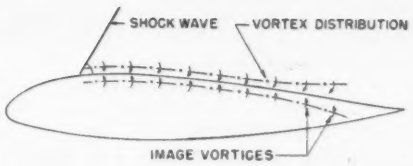


Fig. 4. Vortex distribution behind shock wave.

Further discussion and confirmation of the conjecture of flow instability may be found in early work by Ferri.[4]

When a portion of the airfoil has attained supersonic flow, a shock wave is formed which at first is quite weak. According to Ferri, this wave is not normal to the profile but oblique, and since the air particles are refracted away from the shock front and upward deflection of the air particles takes place, which in turn tends to produce a breakaway of the flow from the body. A. Vazsonyi[5] has shown that rotationality of the field of flow behind the shock wave results, his expression being $q \times \omega = \text{grad } h_o - T \text{ grad } S$, where q is the velocity vector, S the specific entropy, T the absolute temperature, h_o the specific enthalpy at the stagnation point, and $\omega = \text{curl } q$. Since the shock wave is not very intense at first, the effects are very small; or, put in another way, since the abruptness in pressure is infinitesimal, the increase in entropy is also infinitesimal and no appreciable change in the character of the flow may be expected.

As speed is further increased, the shock wave grows in intensity and a point is reached where rotationality of the fluid particles becomes important. We then have a series of vortices distributed throughout the field of flow as shown in Fig. 4.

Since boundary conditions are such that no normal velocity exists, image vortices of opposite strength are placed directly opposite to those in the field of flow. Lamb[6] discusses the stability of double rows of vortices symmetrically placed, as shown in Fig. 4 where a disturbance of the type

$X_m = ae^{im\phi}$
$Y_m = Be^{im\phi}$ for the upper row, and
$X'_n = a'e^{in\phi}$ and
$Y'_n = B'e^{in\phi}$ for the lower row is assumed,

where the above designations m and n represent the mth and nth particles, it is shown that when $a = a'$ and $B = -B'$, the mode of motion is unstable when $\phi = \pi$. This means that any accidental waviness in the streamlines tends to increase.

At low speeds the flow behind the shock is subsonic and the streamtube divergence inherent in the geometry of the rearward portion of an airfoil causes a decrease in velocity, but as the speed of flow is increased, a point is reached where the flow behind the shock wave is supersonic instead of subsonic. The streamtube filaments still diverge, but now an expansion takes place since the field of flow is supersonic. This supersonic flow continues up to the vicinity of the trailing edge of the airfoil where a second compression shock must occur since the air has to return to atmospheric pressure some distance aft of the wing trailing edge. Ferri[4] also states that the rear shock wave tends to approach the first wave, which has an appreciable inclination rearward, and when the two shock waves intersect oscillations in the flow are set up because of the interference effects that result. Fig. 5 shows, roughly what may happen when two shock waves intersect.

Near the point A of intersection, two means of refraction are possible, one due to the shock front AC followed by AE and the other due to the shock front AB followed by AD. The resulting directions of the air particles leaving AE and AD are not necessarily the same. Since two possible directions for the streamlines exist at the point A, there may be a cause for instability in the field of flow, and as a result, an oscillatory condition may be set up. Further complications will arise since the wave AC will be refracted in going through the wave AE and, in turn, the wave AE will be refracted in passing through the wave CA. The question is not settled as to whether a system of two such intersecting shock waves is stable.

It is probable that the study of flow instability requires us to consider viscosity effects. We mention several considerations of this nature. It has been already noted that as the shock wave grows in intensity, the rotationality of the field of flow becomes more intense and a region of highly turbulent flow exists behind the shock wave. As a result of this, we have an abrupt transition of the boundary layer from the laminar to the turbulent state, with a rapid increase of the boundary layer thickness as seen in Fig. 6. The sud-

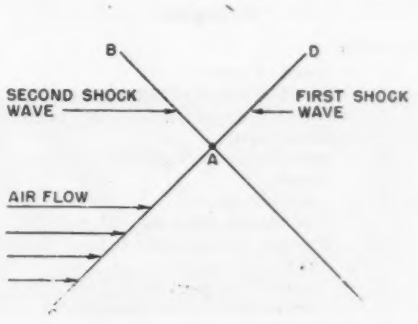


Fig. 5. Diagrammatic representation of two intersecting shock waves.

* Bliss,[3] states: "When a wire circle is dipped in a soap solution and withdrawn, a disk of soap film bounded by the circle is formed. If a second smaller circle is made to touch this disk and then moved away the two circles will be joined by a surface of film which is a surface of revolution in the particular case when the circles are parallel and have their centers on the same axis perpendicular to their planes. The surface of revolution so formed must be one of minimum area."

"The problem of determining the form of a soap film stretched between two circles whose planes are parallel and whose centers are on a common axis perpendicular to their planes, is equivalent to that of determining a curve joining two given points and generating a surface of revolution of minimum area. If the right-hand circle is moved slowly away from the other in the direction of their common axis, the meridian catenary takes successive positions in the one-parameter family of catenary arcs through the point 1. When a certain point has been reached the surface becomes unstable. Without any further movement of the circle it will gradually contract and separate into two portions which retire into the planes of the circles to form two circular disks, the Goldschmidt discontinuous solution of our minimum problem. The moment at which this separation takes place is the one when the point 2 reaches in its horizontal movement the envelope G of the family of catenaries through the point 1." (In Bliss' example it turns out that the film which is actually formed not only depends on the location of the rings along their axis but also depends on the *previous history of their positions*. If the same sort of thing were true of a compressible flow it would be found that the flow existing about an airfoil depended not only on the boundary and the speed but also on how that state of affairs were attained—from higher or lower speeds, with rapid or slow accelerations, etc.).

den thickening of the boundary layer is physically equivalent to a bump on the body, and as a result, flow conditions are altered since there is an interaction between boundary layer and shock wave.

Kelvin, in Lamb's Hydrodynamics,[6] has investigated the stability of laminar motions when viscosity is taken into account, and his general conclusion is that the laminar flow is in all cases stable for very small disturbances, but that for disturbances exceeding a certain limit the motion becomes unstable, these limits of stability being narrower with decreasing viscosity. Study of these phenomena from the standpoint of the modern theory of limit cycles would be very interesting.

Finally, let us consider the flow over an airfoil at sonic speeds. It is obvious that any airfoil must push the streamlines apart. Also, if the finite disturbance does not reach to infinity, some streamtubes must be narrower over the body than in front of the body. Now, consider that a steady irrotational flow has a minimum streamtube area when the speed equals the speed of sound. If the stream ahead of the airfoil is traveling at sonic speed, the streamtubes have their minimum area before they reach the airfoil, and it would be implied that they could not get any narrower to pass over the airfoil. But this is impossible, since they must become narrower. Hence, we expect peculiar effects in the neighborhood of sonic speed regardless of the type of airfoil designed for this region.

The preceding arguments point to instability of flow at high speeds in air, and flight and wind tunnel tests appear to verify this. One may properly inquire whether there is not some better solution to this problem than the construction of aircraft able to withstand unsteady flows. One solution to avoid the difficulty would be to fly as quickly as possible through the speed range at which the flow is indeterminate so as to minimize the time during which something might happen.

Appendix

Symbols:

- c, = Speed of sound
- c_o, = Speed of sound of undisturbed air
- c_1, = Speed of sound immediately behind shock wave
- M_o = speed ratio, or Mach number of free stream
- P, = Local pressure
- P_o, = Free stream pressure
- P_1, = Pressure immediately behind shock wave
- T, = absolute temperature
- T_o, = Temperature of free stream
- T_1, = Temperature immediately behind shock wave
- U_o, = Free stream speed
- u_1 = Speed of air immediately behind shock wave
- ρ_o, = Density of free stream air
- ρ_1, = Density immediately behind shock wave
- ρ, = Density of air

The equation, $T/T_o = 1 + 0.2M^2_o$, in the adiabatic case, may be derived from the fundamental gas laws given in differential form below:

$$\text{Gas Law: } \frac{dP}{P} - \frac{d\rho}{\rho} = \frac{dT}{T} \tag{1}$$

$$\text{Adiabatic Law: } \frac{dP}{P} = 1.4\,\frac{d\rho}{\rho} \tag{2}$$

$$\text{Bernoulli's equation: } udu + \frac{dP}{\rho} = 0 \tag{3}$$

$$\text{Speed of sound: } c^2 = \frac{dP}{d\rho} \tag{4}$$

$$\frac{c^2}{c^2_o} = \frac{T}{T_o} \tag{5}$$

Bernoulli's equation (3) is rewritten by means of (4) and (5)

$$udu + \frac{dP}{d\rho}\,\frac{d\rho}{\rho} = 0$$

or

$$udu + c^2\,\frac{d\rho}{\rho} = 0$$

or

$$udu + c^2_o\,\frac{T}{T_o}\,\frac{d\rho}{\rho} = 0 \tag{6}$$

Using (1) and (2):

$$\frac{d\rho}{\rho} = \frac{1}{0.4}\,\frac{dT}{T} \tag{7}$$

Combining (6) and (7):

$$udu + c^2_o\,\frac{dT}{0.4T_o} = 0$$

Integrating

$$\frac{u^2}{2} + \frac{c^2_o T}{0.4T_o} = \frac{U^2_o}{2} + \frac{c^2_o}{0.4}$$

Letting $u = 0$,

$T/T_o = 1 + 0.2\,M^2_o$

When the flow traverses a normal shock, the problem consists of two parts. First, the temperature ratio through the shock is determined; then the temperature ratio from the rear of the shock to the stagnation point is determined. The fundamental relations for the shock are given below:

Rankine-Hugoniot Law

$$\frac{\rho_0}{\rho_1} = \frac{\dfrac{6\,P_0}{P_1} + 1}{\dfrac{P_0}{P_1} + 6} \tag{8}$$

Continuity:

$$\rho_1 u_1 = \rho_o U_o \tag{9}$$

Momentum:

$$P_1 - P_o = \rho_o\, U_o\,(U_o - u_1) \tag{10}$$

Speed of Sound:

$$c_1^2 = \frac{1.4P}{\rho} \tag{11}$$

Re-writing Eq. (8):

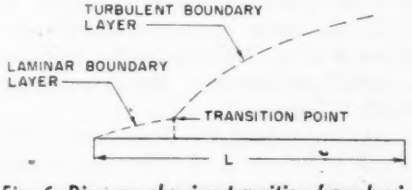


Fig. 6. Diagram showing transition from laminar to turbulent boundary layer.

$$\frac{\rho_1}{\rho_0} = \frac{\dfrac{6\,P_1}{P_0}\,\dfrac{\rho_0}{\rho_1} + \dfrac{\rho_0}{\rho_1}}{\dfrac{P_1}{P_0}\,\dfrac{\rho_0}{\rho_1} + \dfrac{6\,\rho_0}{\rho_1}}$$

Substituting from Eqs. (9) and (11),

$$\frac{U_0}{u_1} = \frac{\dfrac{6\,c_1^2}{c_0^2} + \dfrac{u_1}{U_0}}{\dfrac{c_1^2}{c_0^2} + \dfrac{6\,u_1}{U_0}}$$

or

$$\frac{c_1^2}{c_0^2} = \frac{\dfrac{u_1}{U_0} - 6}{\dfrac{U_0}{u_1} - 6}$$

or using (5):

$$\frac{T_1}{T_0} = \frac{\dfrac{u_1}{U_0} - 6}{\dfrac{U_0}{u_1} - 6} \tag{12}$$

Now (10) may be re-written:

$$\frac{P_1}{P_0} - 1 = 1.4M_0^2\left(1 - \frac{u_1}{U_0}\right)$$

Substituting this value in (8) and using (9),

$$\frac{u_1}{U_0} = \frac{8.4\,M^2_0 - 8.4\,M^2_0\,\dfrac{u_1}{U_0} + 1}{1.4\,M^2_0 - 1.4\,M^2_0\,\dfrac{u_1}{U_0} + 6}$$

which may be solved for u^1/U_o:

$$\frac{u_1}{U_0} = \frac{1 + 0.2\,M^2_0}{1.2\,M^2_0} \tag{13}$$

Substituting this value in (12),

$$\frac{T_1}{T_0} = \frac{7\,M^2_0 - 1}{6}\left(\frac{1 + 0.2\,M^2_0}{1.2\,M^2_0}\right) \tag{14}$$

The Mach number after the shock can be found by using (14) in the form

$$\frac{c^2_1}{c^2_0} = \frac{7\,M^2_0 - 1}{6}\left(\frac{1 + 0.2\,M^2_0}{1.2\,M^2_0}\right)$$

together with (13). It is found that

$$M^2_1 = \frac{5 + M^2_0}{7\,M^2_0 - 1}$$

This can be used with Eq. (13) to determine the further heating when the air compresses at the stagnation point:

$$\frac{T}{T_1} = 1 + \frac{1 + 0.2\,M^2_0}{7\,M^2_0 - 1}$$

Multiplying by Eq. (14) gives the desired relation:

$$\frac{T}{T_0} = 1 + 0.2\,M^2_0 \tag{15}$$

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(1) Von-Karman, Th. and Tsien, H. S., *Boundary Layer in Compressible Fluids*, Journal of the Aeronautical Sciences, Vol. 5, No. 6, pp. 227-232, Apr., 1938.

(2) Bateman, H., *Notes on a Differential Equation Which Occurs in the Two-Dimensional Motion of a Compressible Fluid and the Associated Variational Problems*, Proc. Roy. Soc. A, CXXV, pp. 598-618, 1929.

(3) Bliss, G. A., *Calculus of Variations*, The Open Court Publishing Co., Chicago, 1925.

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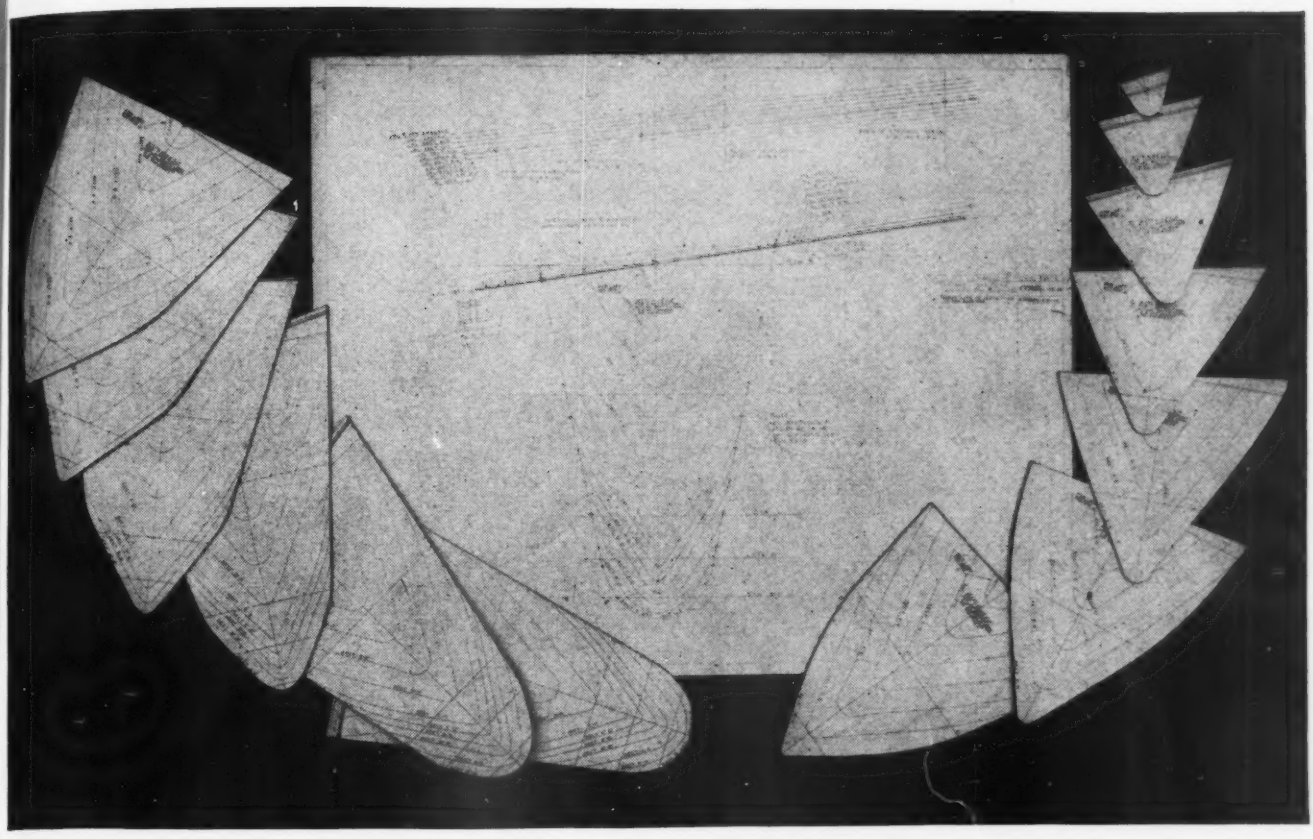


Seen here are master contours and individual sectional templates produced by Loftec.

Layout Reproduction The Loftec Way

For high-gear output of P-47's, a quick, simple, and accurate reproduction process was essential—and so Republic devised this master luminous-paint-coated metal negative unit.

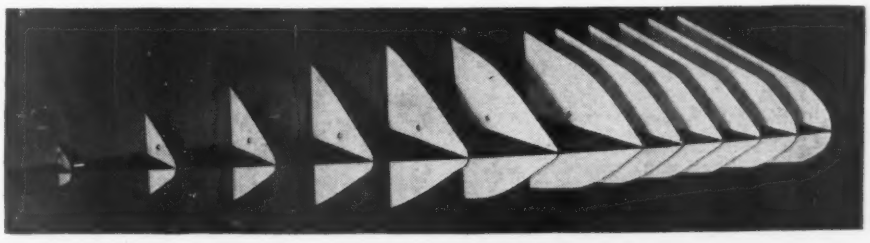
AMONG REPUBLIC AVIATION CORP'S outstanding achievements is a process of layout reproduction—Loftec—regarded by engineers as a major tooling development.

Elementary in principle and operation, Loftec reproduces the most intricate designs in record time, eliminating camera, intermediary negative, and costly X-ray equipment, and utilizes the economical method of spray coating. Moreover, the process requires only a minimum of skill and experience.

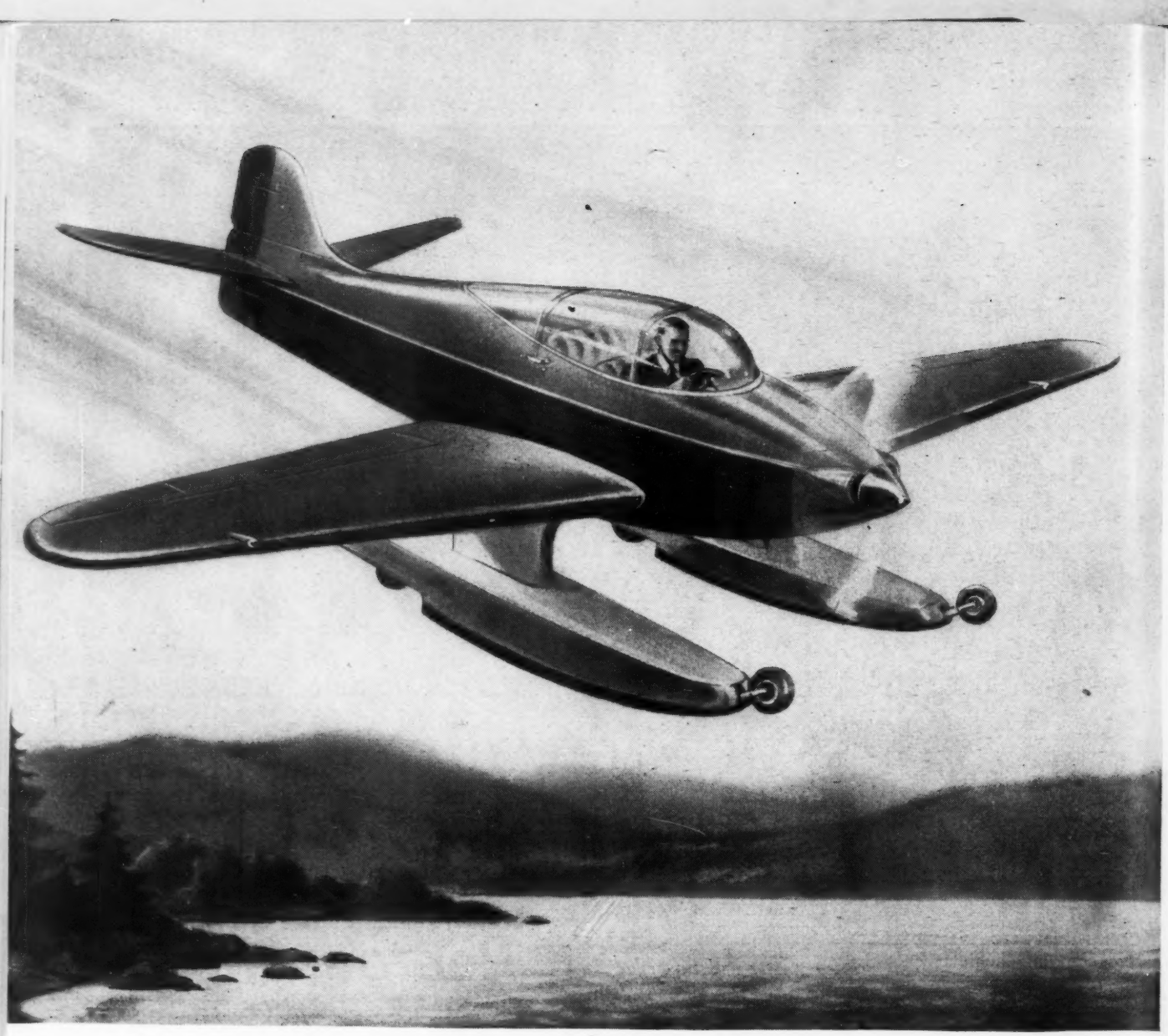
A metal sheet coated with luminous paint and masked with a white lacquered surface is employed. Using a sharp instrument, the draftsman scribes his design through the outer coating to expose the luminescence beneath, thus creating a master negative. And errors are easily rectified by painting over. Lettering, if any, is then scribed in reverse to complete the master negative. For designs or layouts less than 20 by 50 in., a transparent plastic (Vinylite) is used.

Exposure of the luminous negative to strong light—natural or artificial—activates the design to glow in a dark room. Obtaining prints from this negative is photographic routine, the Loftec sheet being placed in a contact printer with a sensitized sheet of material for 90 sec. Development of wood, paper, plastic, or metal positives is by processing with usual fixing solutions, and after washing and drying, the reproductions are ready for use.

Republic concedes that its high Thunderbolt production (15,000 craft off the assembly lines in about 3 yr.) would not have been possible without Loftec. Although the process was developed in the field of aviation, it is not necessarily confined to that industry, but is applicable wherever tools, jigs, fixtures, templates, and dies are used.



Skeleton form assembled from Loftec templates.



DESIGNING TOMORROW'S PERSONAL PLANE

PART VI

By RALPH H. UPSON, *Consulting Engineer*

THIS ARTICLE is somewhat of a digression in a series otherwise devoted to landplane types, which we have examined as to their fitness for future production. Judging by appearances and past history, the amphibian is a specialty-combination type in a similar class with the roadable[1]; and yet it may be enough simpler than the roadable in its basic elements to present a possibility for relatively attractive performance as well as low price.

Although a seaplane is naturally more restricted in use than a landplane, it might be argued that a combination of both would have a broader use than either; and of course it would if it carried no penalty. Actually, to look at the dark side first, the case *against* the amphibian might be stated something as follows:

1. Floats, or a stepped boat hull, with the necessary lateral and longitudinal flotation distribution, weigh more than wheels, and usually have more drag—much more drag than retracted wheels.

2. Retaining the wheels means further weight, and also further drag unless they are retracted out of the air as well as out of the water.

3. The weight and drag of the combination is increased by clearance and control requirements, including a steerable water rudder as well as steerable ground wheel.

4. A majority of flyers would have too little need for water facilities to justify much added cost.

5. The normal maintenance problem of a seaplane hull is complicated in an amphibian by landing gear strains and by not having a

[1] See Part V, October AVIATION.

continuous check on whether the hull is beginning to leak.

6. Eventually nearly all flight destinations of general interest will probably have landing strips.

7. For restricted and special use, including water landings, over the shorter distances, the helicopter seems to offer an attractive solution.

On the other hand, although there has been enough experience with the amphibian to banish the idea that it will ever be a universal type, a good case *for* it can be set up along the following lines:

1. Most large cities are on waterways that provide landings closer to the business centers than do regular airports.

2. The amphibian offers direct transport to points difficult to reach by any other means; and therefore seems particularly attractive for hunting, fishing, and vactioning in general, for those who like to get away from the beaten track.

3. For a time at least, flying is in any case going to cost somewhat more than driving; and its appeal must be other than in the mere travel cost per mile. Such an appeal may well be found in the amphibian's ability to land in a wilderness of forests and lakes or in any protected cove along the coast.

4. From a safety standpoint, the amphibian will often have a better chance (sometimes the only chance) of making a good emergency landing.

All this may begin to sound like a high school debate, especially since there are now some plausible items of rebuttal, such as that water flying has difficulties of its own to be learned, and that landing in unsettled regions means lack of supplies and facilities so essential to such a highly mechanical contrivance as the airplane.

Omitted from the *pro* list of items has been the rather ill defined argument, often heard, that it *ought* to be possible to design an amphibian much simpler than anything hitherto developed. If such design is to depend on a more simple basic arrangement of parts, its justification must of course come back to a comparison of specific cases. Seemingly in support of the general possibility is the fact that floats

What of the amphibian? Here, though beset with admitted difficulties and objections, Mr. Upson concludes that development of this type may well lead to a craft of new and broader feasibility, and he presents cogent design ideas pointing the path.

can so readily be applied to almost any lightplane at a cost increase which, in reasonable production, would probably be no more than about 20 percent of the landplane price.

The increased wing loading and the decreased climb, speed, range, and load factor are simply accepted and are usually approved. But, as already indicated, the amphibian is something else again. Although a seaplane, it must also be designed as a landplane; and with particular reference to the lower load factors now proposed, it seems unlikely to rate any special dispensations in the airworthiness requirements.

If the amphibian is to be used over relatively rough terrain, where its principal appeal may develop, the validity of much less range or greater wing loading may be questioned, and speed can only be sacrificed if it can be done without seriously affecting takeoff and climb. Thus we can little afford to be careless of drag, considering its effect on range; yet wing and power loading must be reasonably maintained, mainly on account of takeoff. All-in-all, a reasonable first approach to the general problem would appear to rest on an assumption of the same carrying capacity and major performance objectives as have been used in our previous comparisons of different landplane types (as sketched in Part II, July AVIATION). To summarize these assumed objectives:

Useful load, less fuel, 575 lb. (three place).

Range at 120 mph. (7,000 ft.) 600 mi. ultimate or approximately 500 mi. net.

Wing loading, 10 lb. per sq. ft.

Maximum power loading of 17 lb. per hp.

Single engine; high-lift, low-drag flaps; aspect ratio six.

As developed in the preceding article, if a weight of say 100 lb. is to be added to the equipment, the original objectives can be maintained only by a further addition of 66 to 90 lb., depending on the design type. The same applies in this case to weight directly involved in a redesign for amphibious use. But here the drag increase is likely to be in higher proportion than the weight, which introduces another useful principle of broad application.

Table 1—Effect of Increased Drag Area and Weight

Design type	Total inc. of net drag area (Per sq. ft. of initial drag increase)	Attendant wt. inc. (Per sq. ft. of initial drag increase)	Total inc. of wt. per initial lb. increase
A (Low-wing, retractable tri-cycle gear)	1.08 sq. ft.	75.3 lb.	1.90
B (Low-wing retractable conventional gear)	1.07	72.7	1.83
C (Low-wing, fixed conventional gear)	1.09	72.1	1.79
D (Braced high wing fixed, conventional gear)	1.21	142.8	1.66
E (Braced high wing pusher, fixed tri-cycle gear)	1.26	157.5	1.78

Primary and Secondary Drag

Using the standard symbols, the drag here considered is the direct or so-called parasite type expressed in terms of the net drag area $f_n = SC_{Dp} = D_p/_q$ excluding induced and cooling drag. A small change in drag is then expressed by the increment df_n at a given lift coefficient, the latter remaining constant because of the assumed constant wing loading and indicated speed. For small changes, the weight equivalent is substantially a straight-line function of drag, and it can therefore be based on any convenient increment, such as 1 sq. ft. of drag area.

Similar to the definition of primary weight, a primary drag increase will be defined as the drag increment directly involved in a proposed change, neglecting any indirect accretions, such as for pulling the extra wing area accompanying the increased weight. In section *b* in the appendix of Part II of this series (July), the existing primary drag f_p may be recognized as applying to the sum of all the numerical items not varying with W or $hp._{cr.}$

Thus for our Type A design, the net drag area (excluding cooling drag) $f_n = f_p + .0010W$ which substituted in Eq. (7), gives $3hp._{cr.} = 39.8\ f_p + .068W$. Substituting the latter expression in the weight equation for Type A (Sec. a6) gives:

$W = 1075 + 39.8f_p + .472W$

$= 1075 + 39.8f_n + .432W$ from which:

$df_n/df_p = 1 + .001dw/df_p \approx 1.08$

and $dW/df_p = 39.8/(1 - .472) = 75.3$ lb/sq. ft. ÷+

A similar process for the other design types gives the results, as shown in our accompanying Table 1, for an increase of *1 sq. ft.* primary drag area (equivalent to about 30 lb. of actual drag under the assumed cruising conditions) to which is added a final column

reproducing the weight data from the preceding article.

The first thing that will be noted about the figures (Table I) is the quite moderate character of the total drag increases, much less than for weight alone, as shown by comparison of the first and last columns. The weight equivalent of drag, in the middle column, although substantial, is less in percentage of the total than the percentage of actual drag increase. The sharp difference between the first group of three (Types A, B, and C) and the last two types is due to the fact that the rated power of Types D and E had to be increased to maintain the required cruising speed. For Type C, the cruising speed would actually become critical before a full square foot of drag area could be added.

As shown by the above figures, for a primary drag increase, the penalty in weight (and cost) of maintaining cruising speed at an equal fraction of rated power is roughly double what it would be for maintaining the power loading (and approximate takeoff distance). This penalty will be further increased at higher cruising speeds, unless the wing loading can be substantially increased.

The effect of departure from a true primary type of drag is clearly shown by reference to the example at the end of Part I of this series (June AVIATION). Here the initial drag increase was mainly due to an assumed change in the wing from a clean construction to one with relatively high drag. Hence the final drag was stepped up not only by the increased wing area but also by a factor substantially increasing its drag per sq. ft. Fortunately, in the case of the amphibian, there appears little reason to go far afield from the general construction represented by the more advanced types of wings. In the strict sense, the weight and drag of the floats themselves depend on the gross weight they have to carry and hence are not really in the primary class, but this factor is readily allowed for. The above principles will now be applied to a specific design.

Conversion of a Landplane

The implication here is not that it is ordinarily feasible to convert an actual landplane to an amphibian, but simply that it is convenient to start with a recognized type of landplane and use what we can of the design, plus standard floats, before considering various special arrangements. Type A (low-wing tricycle gear) is chosen as an example from among the designs previously tabulated in our "Score Card" (Part II, July AVIATION), the tricycle gear or something similar being probably best adapted to amphibian use. This craft, as a three-place landplane, has a gross weight of 2,200 lb. and a net drag area (excluding cooling drag) of 4.4 sq. ft.

Table II—Design Data for Type A Landplane and Two Amphibians

Design Type	Landplane A	Amphibian A-1	Amphibian A-2
Wing loading	10.	10.	13.3
Gross weight (lb.)	2200	3460	2930
Fuel and oil (lb.)	213	375	245
Weight empty (lb.)	1412	2510	2110
Useful/gross (%)	35.8	27.5	28.0
Rated power (hp.)	129.5	203.5	172.5
Cruising/rated (%)	61.	68.	66.
Wing span (ft.)	36.3	45.5	36.3
Maximum speed(mph.)	139.3	132.3	141.0
Maximum climb (fpm.)	570.	575.	530.
Comparative cost (approx.)	1.00	1.78	1.50

Under the assumption of 100% surplus flotation, a close empirical representation of the minimum weight (lb.) of floats and connecting struts[2] is: $63 + 117\ W_o$. A low estimate for the additional length of wheel gear and miscellaneous weight (including extra tail area to stabilize the float volume) increases the total primary weight, chargeable to the amphibian, to:

$$W_a = 69 + .13W_o \qquad (1)$$

where W_o is the final gross weight.

The primary net drag increase (sq. ft.) due to the floats,[3] struts, and miscellaneous, is similarly:

$$f_a = 2 \times 0.008W_o^{2/3} \qquad (2)$$

which for the range of W_o around 2,500 to 4,500 lb. can be approximated by the simpler relation:

$$f_a = 1.2 + .007W_o \qquad (2a)$$

Then from the data for Type A in Table I, the final gross weight comes out as:

$W_o = 2{,}200 + 1.9\ (69 + .13W_o) + 75.3\ (1.2 + .0007W_o) = 3{,}460$ lb.

For the assumed power loading, the rated power is 3,460/17 = 203.5 hp.

The net drag area is

$f_n = 4.4 + 1.08f_a = 8.32$ sq.ft.

For 74% net efficiency the cruising power $hp_{cr} = (1/.74)(9.55 \times 8.32 + .0067 \times 3{,}460) = 139.0$ (Eq. 7 in Part II).

The gross drag area $f = f_n + .0063\ hp._{cr.} = 9.20$ sq.ft. (Sec. b3, same article)

A comparison of the original Type A and its amphibian cousin A-1, of the same carrying capacity (three place) will then appear as in the first two columns in Table II, to which is added a third column for a *modified* Type A-2, to be explained later.

As the comparative cost is assumed directly proportional to the weight empty, the cost is, if anything, optimistic for the amphibian in view of its probable smaller volume of production, except to the extent that the same jigs, tooling, and assemblies might be used for both types. It may incidentally be noted that Type A landplane is somewhat heavier and more costly than the other two low wing types.

Another Method

An alternative solution that will readily suggest itself is to keep the same power and gross weight, and take the weight of floats, etc., out of the useful load. This means substituting the original 2,200 lb. in Eq. (1), which gives $W_a = 378$ lb. If the 575-lb. weight of occupants and baggage is reduced by this amount, it is apparent that we would end up with the pilot alone and 27 lb. of baggage.

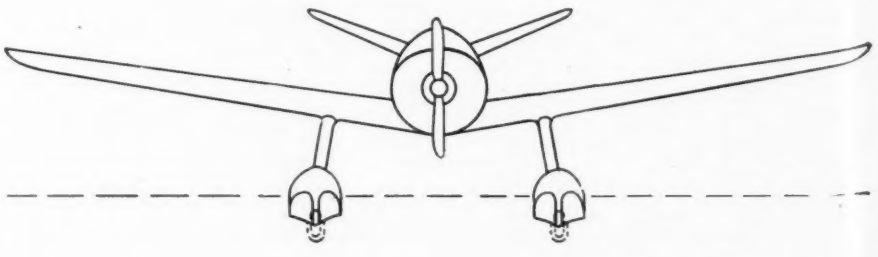
Some of the difference, however, can be recovered by the saving in seat weight and by a smaller, lighter fuselage. With the further saving that could be made by a reduction of power to what would just meet the climb requirement, it appears barely possible to produce a two-place amphibian of reduced perfermance in a similar price class with the three-place landplane, if production can be assumed in comparable quantities.

As this procedure leaves the wing as the only major assembly in produc-

[2] Data based on Teichmann (*Airplane Design Manual*).

[3] Data from Diehl (*Engineering Aerodynamics*), checked against full scale tests.

Fig. 1. Aimed at utmost utility with least sacrifice in cost, weight, and drag is this "A-2" amphibian, metamorphosed through Type A-1 from its "cousin" the Type A landplane (shown in Fig. 2) which was developed earlier in this series.



tion common to the two types, it becomes of interest to see what might be accomplished by a complete redesign.

Alternative Design Arrangements

Special operating requirements will of course narrow the choice of possible arrangement for the major parts. For example, a beaching requirement with exit forward practically dictates a pusher propeller most commonly applied to a boat-type hull. On the other hand, ability to pull up alongside a high dock apparently calls for twin floats spaced widely enough to protect the propeller (whether tractor or pusher), and of course a high wing and tail with no braces outside the floats. A high wing also gives maximum clearance from rough water. But as indicated by our previous analysis of landplane types, weight and cost both increase as the wing is moved up, and as the engine is moved up or back. This is not to say that the above-mentioned accomplishments are necessarily impractical, but that special demands of this nature should be made only with full knowledge of what they will cost in pounds and dollars.

Due to the extra parts and functions inherent in the amphibian, and also because amphibians in general are still in a more primitive state of development than the more standardized landplanes, the different design arrangements apparently worth considering are far beyond the limits of this article. The writer has, however, investigated a number of these possibilities and presents herewith the one which, of all the more conservative types, apparently comes closest to meeting requirements of the low-price market (see Fig. 1, Column A-2 in Table II).

Here the same size wing as the landplane prototype is used, in deference to its production advantage and the enlarged choice of takeoff and landing spots available to an amphibian. The same power loading, however, is retained, which in practice of course means approximating the required power from engines currently available. Although tank capacity for the same ultimate range is assumed, 60 lb. of the baggage and extras is made convertible into fuel and an equal amount normally omitted from the fuel load.

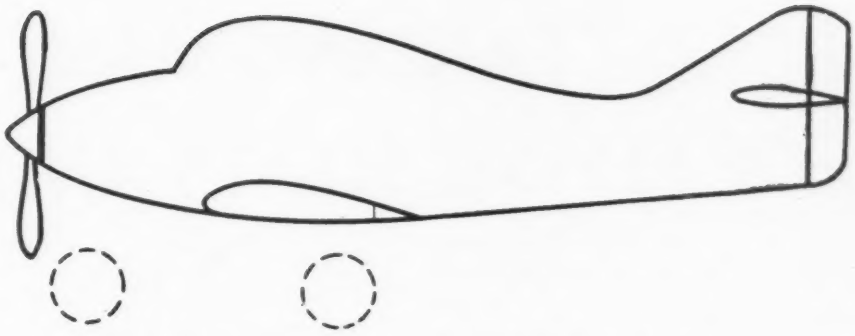


Fig. 2. Type A landplane, design of which served as starting point for A-2 amphibian analyzed in this article.

The advantages of this layout should be fairly obvious. The improved float design with short connecting structure minimizes weight and drag. Simple and effective retraction is facilitated by the wheel arrangement shown.[4] The rear wheel on each float swings up around a single pivot into a center well which, being behind the step, requires no closing door. The steerable front wheels similarly swing into stagnation points forward of the floats.

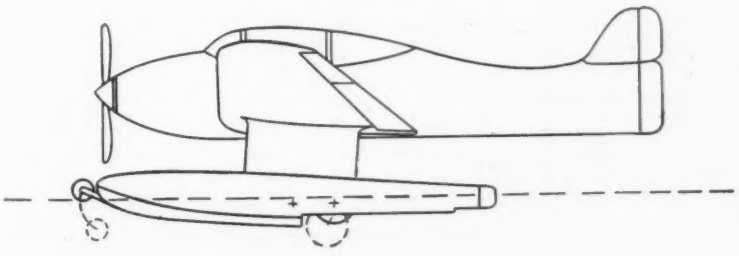
The basic structural economy and faorable engine placement[5] of the better landplane types is retained, also there is even better protection in case of accident. The fuselage and much of the wing construction remain the same as for the companion landplane type. For the private pilot, twin floats are held by this writer to be preferable (either to wingtip floats or sponsons) because of their large hydrostatic stability and their adaptability to a modern coordinated control system. Their wide spacing provides desirable stability both on land and water, with propeller protection and easy access either from the front or rear. The low docks common to most lakes can be readily negotiated. Tail interference, laterally as well as longitudinally, is minimized by the location and dihedral of the tail plane.

The weight and performance figures speak for themselves. Those for the more conventional design in the second column of Table II show only too clearly why the amphibian has been no easy problem. By substituting the original gross weight of 2,200 lb. in equations (1) and (2), it is apparent that the primary weight and drag increases are 355 lb. and 2.70 sq. ft., respectively; which doesn't seem bad till we find that with secondary effect the total increase is actually 1,260 lb. and 4.28 sq. ft., respectively, making the final weight and drag even greater than corresponding minimum figures for the roadable craft estimated in our preceding article (Part V, October AVIATION). The amphibian's major parts, however, appear capable of structural and aerodynamic coordination to an extent permitting substantial savings, as indicated by the more moderate figures in the last column of Table II.

Thus the amphibian is brought into a weight, power, and cost class closely comparable with a similar-size airplane designed for limited road use. Although the future of roadables will undoubtedly remain uncertain until appreciable experience can be had with them, there is already enough backlog of experience with amphibians to indicate a real field, especially if they are of a type that can be largely fabricated from landplane parts and production equipment, the indicated cost being on the order of 50% more than for an equivalent landplane. Therefore it seems reasonable to conclude that, in spite of past disappointments and admitted difficulties, with suitable design the amphibian may yet achieve a modest but honored place in the production of personal aircraft.

[4] For theory of the four-wheel gear, particularly appropriate to this design, see "New Developments in Simplified Control," *Journal of the Aeronautical Sciences*, Dec., 1942.

[5] See discussion of pusher difficulties in Part IV, Sept., 1945 AVIATION.



LANDING ANALYSES FOR FLYING BOATS AND SEAPLANES

PART II

By ERNEST G. STOUT,

Staff Engineer in charge of Hydrodynamics, Development Design Staff, Consolidated Vultee Aircraft Corp.

Continuing his comprehensive discussion of landing phenomena, the author concludes his rough water analysis and presents details of impact integration.

WE NOW COME to the analytical treatment of rough water performance, which involves the deliberate operation of aircraft in rough water to obtain accurate technical information on the accelerations and handling charactertistics of a specific aircraft through the use of scientific instrumentation. There are two generally accepted methods for conducting this analysis. First—and most common in use today—is the installation of accelerometers throughout the airplane, with dependence upon these instruments and observers on board the craft to determine and record the data. These data are correlated and analyzed to obtain final characteristics. However, this system has several fundamental disadvantages:

1. To obtain accurate readings of

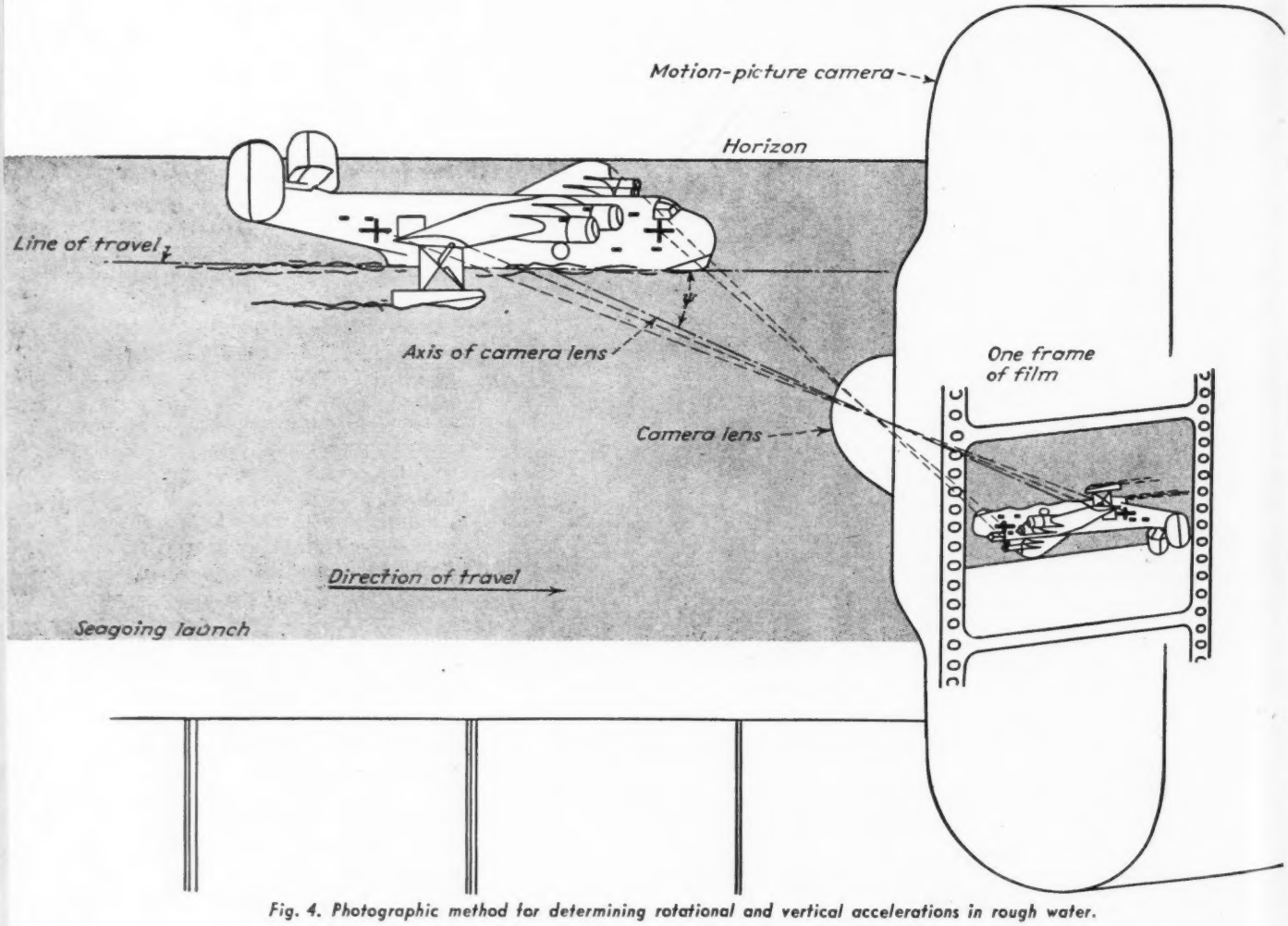


Fig. 4. Photographic method for determining rotational and vertical accelerations in rough water.

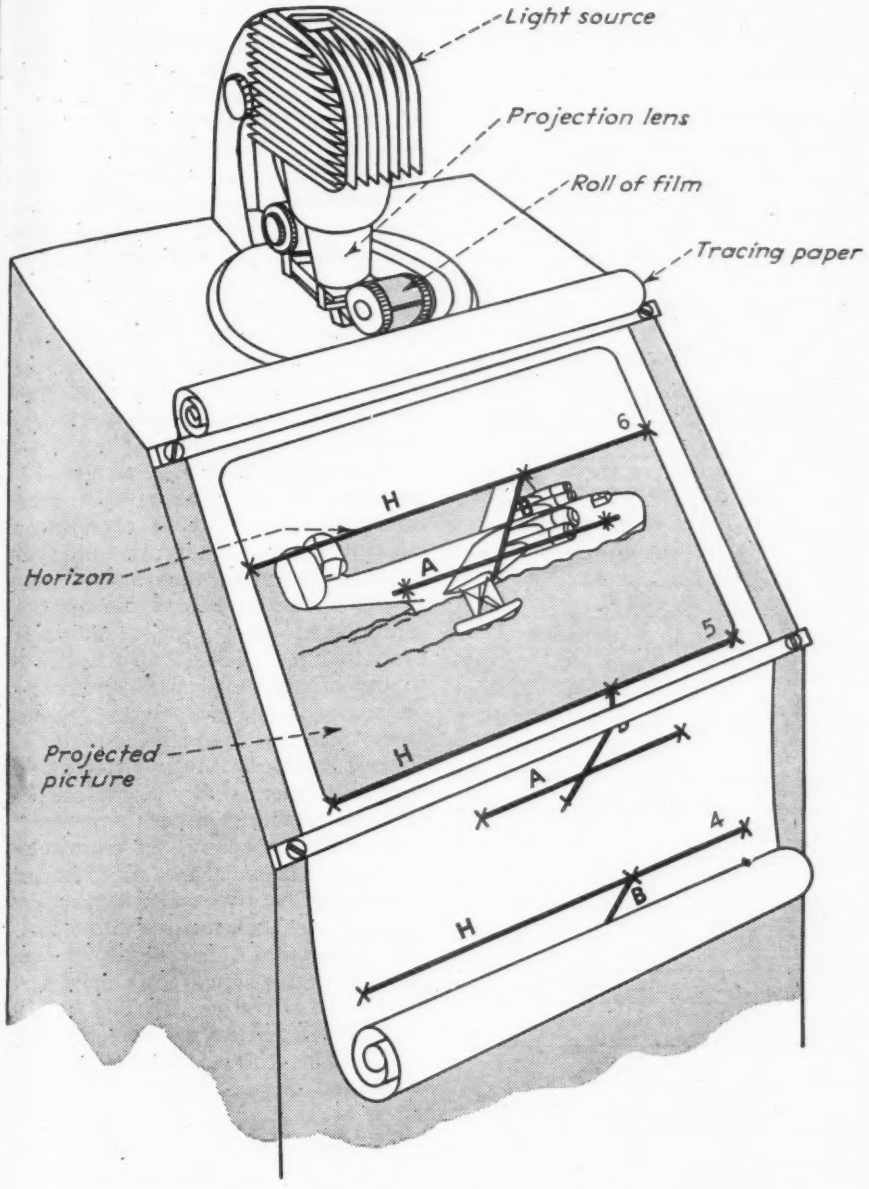


Fig. 5. Diagram of film viewer used to record reference points from rough water films.

translational and rotational accelerations, it is essential that all accelerometers in the ship record at precisely the same instant, and this involves elaborate timing and sequence circuits.

2. For this type of test there is not a simple and completely satisfactory accelerometer available that will continuously record accelerations that are exactly sequenced with other such recording instruments. Most accelerometers used for this type of work have bad damping characteristics and pick up stray resonant frequencies. It is much more difficult to measure mechanically a series of sharp accelerations than a steady pullout.

3. In the event of loss of the plane, all records and technical evidence bearing on the cause of the failure are lost.

The second method, while less familiar, overcomes all of these disadvantages, and experience with both systems has indicated better accuracy with this photographic analysis. Only equipment necessary is a good 35 mm. camera with a telephoto lens and a Recordak or shadow box. This eliminates mechanical failures in elaborate instrumentation with accompanying hazards of re-running tests. Following is a brief summary of the theory and procedure for this analysis:

Since this system is based on the theorem of descriptive geometry dealing with the relation and proportionality of true length to foreshortened length, it is only necessary to determine a fixed longitudinal and lateral reference on the airplane, the true length of which are known, and record on photographic film the foreshortened relationship of these lengths from some point away from the airplane. Since it is only necessary to obtain the proportionality, the distance from the camera to the airplane need not be known and can even vary during a run.

Hence, the only preparation required before the test is to provide a boat which serves as a platform for the camera and alongside of which the airplane makes takeoffs and landings. To provide a relatively secure platform and facilitate following the airplane in the viewer of the camera, the boat should be of sufficient size to minimize pitch and roll in the sea. Usually a boat of the minesweeper or ocean tug class is preferable. Also, to facilitate reading the films it is advisable to mark the side of the hull of the airplane with a series of large crosses located longitudinally and parallel to the deck line, and also, a vertical series, intersecting the former at the C. G.

The boat then steams into the wind with just sufficient headway to maintain control. The airplane is operated close as possible to the boat, consistent with safety, and a moving picture record, with the camera run at a known constant speed, is taken of the flare contact and up until the airplane loses headway.

The analysis comprises checking of the moving picture record, frame by frame, in a shadow box or film viewer such as a Recordak. Because of the relative motion between camera and airplane, it is first necessary to correct for angularity between the camera and the path of the airplane, ψ. This is done as shown in Fig. 4, where dimension A is a known longitudinal reference distance, such as the first and last longitudinal cross, distance from pilot's window to rear hull window, or the like; and B is a corresponding lateral reference, such as wing tip to wing tip, propeller dome to propeller dome, or some other such distance. As the film is run through the viewer one frame at a time, the foreshortened values A and B are traced off onto a strip of vellum, which moves across the ground glass as illustrated in Fig 5.

Tangent of the angle ψ will then be

$$\tan \psi = \frac{B}{A} \times \frac{\text{true length } B}{\text{true length } A} \qquad (20)$$

from which ψ can be determined.

To complete the analysis, the horizon

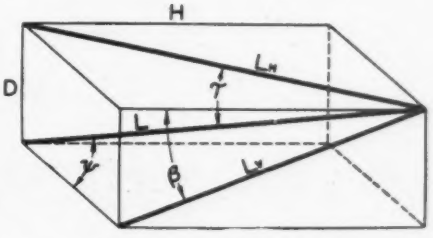


Fig. 6. Geometry for determining true angle of trim to horizon.

Table II—Landing Impact Computations

Model .....
Date .....

Gross wt.	41,500 lb.	$C_{L\ max}$	2.0
Wing area	1,780 sq. ft.	V_{stall}	67.6 mph.
Wing loading	23.3 lb./sq. ft.	v_g (1.1 V_{stall})	109 fps.
Beam	10.5 ft.	$C_{L_{glide}}$	1.65
Deadrise angle	22 1/2 deg.	L/D_{glide}	9.1
Trim (at contact)	8 deg.	Flight path, θ	6.25 deg.
Calculated by		v_s	11.9 fps.

(1/2 ground effect assumed)

1	2	3	4	5	6	7	8	9	10	11	12
Total S-in.	ds ft.	Av. S in.	$\frac{w.l.}{b}$	C_{L_p}	L_p lb.	B lb.	$L_p + B$ lb.	da ft./sec.^{2}	$ds \times 2da$	v^2_s fps.	v_s fps.
0										141.7	11.9
	.50	3.0	.13	.0019	2,490	750	3,240	2.51	2.51		
6										139.2	11.8
	.25	7.5	.36	.0110	14,400	2,500	16,900	13.10	6.31		
9										132.9	11.5
	.25	10.5	.50	.0210	27,500	4,100	31,600	24.50	12.28		
12										120.6	11.0
	.25	13.5	.65	.0345	45,150	6,000	51,150	39.60	19.85		
15										100.8	10.0
	.25	16.5	.80	.0495	64,800	8,400	73,200	56.75	28.40		
18										72.4	8.5
	.125	18.75	.92	.0610	79,900	10,200	90,100	69.80	17.44		
19.5										54.9	7.4
	.125	20.25	.98	.0670	87,750	11,600	99,350	77.00	19.25		
21.0										35.7	6.0
	.125	21.75	1.06	.0748	98,000	13,000	111,000	86.10	21.53		
22.5										14.1	3.8
	.125	23.25	1.14	.0830	108,800	14,600	123,400	95.70	23.92		
24.0										−9.8	−3.1

S = draft
$w.l./b$ = wetted length/beam
C_{L_p} = planning lift coeff.
L_p = hydrodynamic lift
B = buoyancy

$L_p = .9946 C_{L_p} \times b^2 \times v^2_s = 1{,}310{,}000 \times C_{L_p}$

$da = (L_p + B)g/w = .000775 \times (L_p + B)$

$ds = (v_1^2 - v_2^2)/2da$; $v_2 = \sqrt{v_1^2 - (ds \times 2da)}$

$\theta = \cot^{-1} L/D$

$v_s = v_g \times \sin \theta$

and a clearly defined longitudinal baseline, such as the longitudinal crosses, the deck line, or painted waterline, is traced at the time the reference points are plotted. This gives a foreshortened angle of pitch, β, which is corrected for the angularity, ψ, to give the true angle of pitch or trim, τ, of the airplane. This is based on the assumption that the horizon is infinite and provides a true horizontal. The correction to the foreshortened angle of pitch, β, is illustrated in Fig. 6 where faired values of ψ and β are used to obtain τ.

In Fig. 6,

$$\sin \psi = \frac{L_v}{L} \tag{21}$$

$$L = \frac{L_v}{\sin \psi} \tag{22}$$

and,

$$\sin \beta = \frac{D}{L_v} \tag{23}$$

$$D = L_v \sin \beta \tag{24}$$

Also,

$$\sin \tau = \frac{D}{L} \tag{25}$$

$$= \frac{L_v \sin \beta \sin \psi}{L_v} \tag{26}$$

therefore,

$$\sin \tau = \sin \psi \sin \beta \tag{27}$$

If the traced longitudinal baseline is not the airplane's trim baseline, any true angularity between the two is added or subtracted. For example, if the painted waterline was used for the trim reference and it is painted on the hull at an angle of −2.5 deg. to the forebody keel, which is the trim reference line for the airplane, all values of true angle of the waterline to the horizon would be increased 2.5 deg.

To obtain the rotational acceleration in radians per sec. squared, the observed values of ψ and β are plotted, as shown in Fig. 7, against frame number and, knowing the speed of the camera, frame number can be transposed to time in sec. The observed values of ψ and β are faired to take out small irregularities, and the true angle of pitch, τ, is determined from equation (27) and plotted. First derivative of angular displacement, θ, versus time, t, gives angular velocity, ω. The curve of true angle of trim, τ, versus time is differentiated by taking the slopes of the curve and is plotted as angular velocity in radians per sec., ω, versus time as shown in Fig. 7.

Second derivative of angular displacement versus time gives angular acceleration, α. This is obtained by taking the slopes of the curve of angular velocity versus time and plotting as angular acceleration in radians per sec. squared versus time, as shown in the bottom plot of Fig. 7. To save time in the original analysis it is usually customary to analyze only every tenth frame of the picture until the region of highest acceleration is determined; then this region is fully determined accurately by filling in each frame.

Acceleration because of translation is obtained in much the same manner except that only the vertical displacement of the C. G. relative to the horizon is required. The vertical movement, s, versus time, t, is plotted, and the first derivative of this curve, ds/dt, gives vertical velocity, v, of the C. G. This curve is plotted and the derivative, dv/dt, gives the vertical acceleration, a. A typical plot of this analysis is illustrated in Fig. 8.*

It will be found that the time spent on the film analysis is about equal to the time required to analyze the accelerometer records—saving the cost and time for elaborate instrumentation and necessary re-runs when the instruments fail to operate satisfactorily. Based upon experience with both methods, the final results of the camera method are more accurate—particularly in the determination of rotational accelerations.

Landing Impact Integration

Until recent years, very little consideration had been given to any analysis of the landing regimen of fly-

* The vertical translation in ft. is obtained from a vertical reference on the airplane, such as the vertical tail, the true height of which is known. The measured distance on the projected image from the C.G. (intersection of horizontal and vertical painted crosses on the airplane hull) to the horizon multiplied by the ratio of the true height of the vertical reference to the image height, will give the true distance of the C.G. from the horizon. The plot of vertical displacement in Fig. 8 is the trace of the C.G. with reference to the horizon which is referenced as the origin.

ing boat operation except that necessary to meet the rough water requirements. Hull bottom structure has been arbitrarily designed to a yield load factor of 6.0—found through accumulated experience to give adequate strength. This criterion was established many years ago when wing loadings rarely exceeded 25 lb. per sq. ft., and by rule of thumb was found to be adequate and generally considered to be independent of wing loading.

But in recent years, modern flying boats, built to this standard with wing loadings of 50 lb. per sq. ft., and more, have experienced a great increase in hull failures—indicating that further investigation of the landing function is justified. Before any analytical study of this nature can be set up, it is necessary to establish a procedure, and relationship among the major parameters involved. The author has developed such a method, which lends itself to analytical landing solutions and consists of evaluating what is called the "impact integral." This analysis and a typical procedure is presented below.

Theory of the Impact Integral: Impact integration was primarily developed to study the effect of wing loading on impact accelerations. The method consists of holding constant all of the major flight parameters, except wing loading, with landing trim an independent variable. In this manner, pilot technique is eliminated completely. This results in a qualitative analysis which may then be broken down into a quantitative analysis for a specific case by taking into account the factors involved in pilot technique —flare at landing, use of power, etc.

Basically, it is assumed that the airplane approaches the water in a steady glide at a speed 10% above the stall, and contacts the water with no deceleration due to flare. The flare is assumed to be only rotation to the predetermined trim for which the analysis is made. By assuming various landing trims, impact acceleration versus trim for a constant set of approach conditions may be plotted. After contact, the trim is assumed to remain constant until maximum deceleration is obtained, which occurs at the point where the sinking speed v_s is equal to zero.

The impact integral is,

$$S = \int_{v_s}^{v_o} \frac{w}{g} \frac{v\,dv}{(L_p + B)} \qquad (28)$$

where S is the draft of the hull in ft. measured at the main step, the limits v_s and v_o are the sinking speeds at contact and zero, respectively, w/g is the mass, v is the sinking speed in ft./sec., and $(L_p + B)$ is the decelerating force—consisting of the planing or dynamic lift, L_p, and the buoyancy, B, in lb. This integral indicates that the draft is integrated with respect to the sinking speed from the initial steady sinking speed at contact to sinking velocity of zero. In other words, the integral determines the maximum draft attained when the vertical velocity is zero and the deceleration is a maximum. Inspection of this integral shows that it is very similar to the takeoff distance integral equation (Part II, *Takeoff Analysis For Flying Boats and Seaplanes,* Aug. 1944, AVIATION) and it is derived in the same manner. Here, however, the analysis is in a vertical plane and the distance, S, becomes the draft, d, and the velocities are vertical speeds.

There are two forces acting to decelerate the airplane—static buoyancy and dynamic lift of the hull bottom as a result of trim and forward velocity. For the particular airplane in question, curves of buoyancy versus draft for several values of trim are plotted as shown in Fig. 9. These data are readily obtained from the displacement model discussed in *Experimental Determination of Hull Displacement,* Apr. 1944, AVIATION, and furnish the static contribution to the deceleration. To

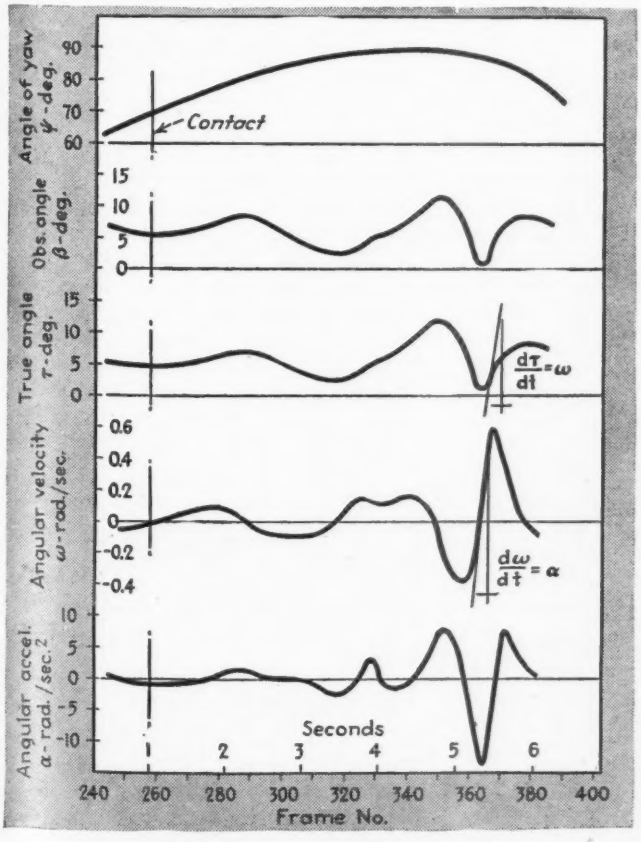


Fig. 7 Plot of yaw, trim, angular velocity, and angular acceleration vs. time, as determined from photographic rough water analysis.

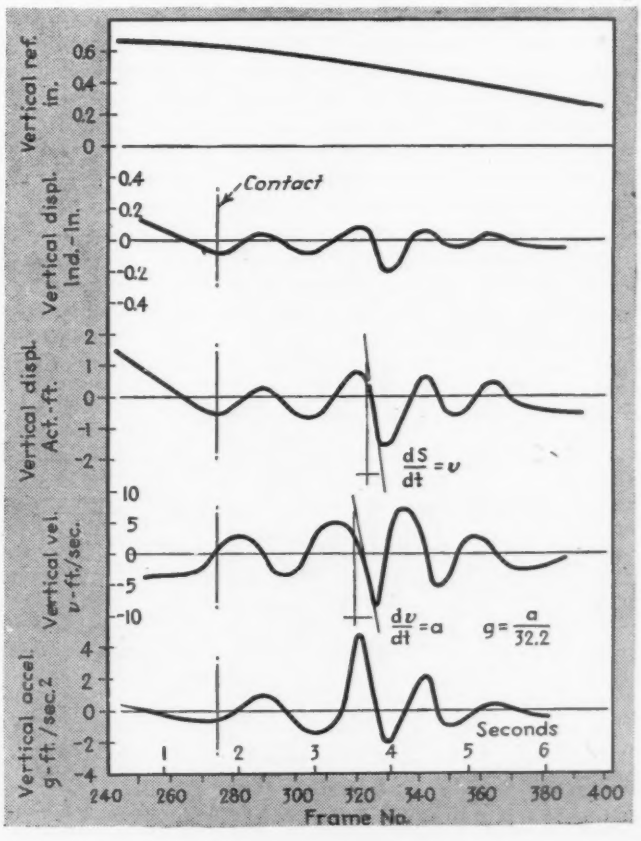


Fig. 8. Plot of displacement, vertical velocity, and vertical acceleration vs. time, as determined from photographic rough water analysis.

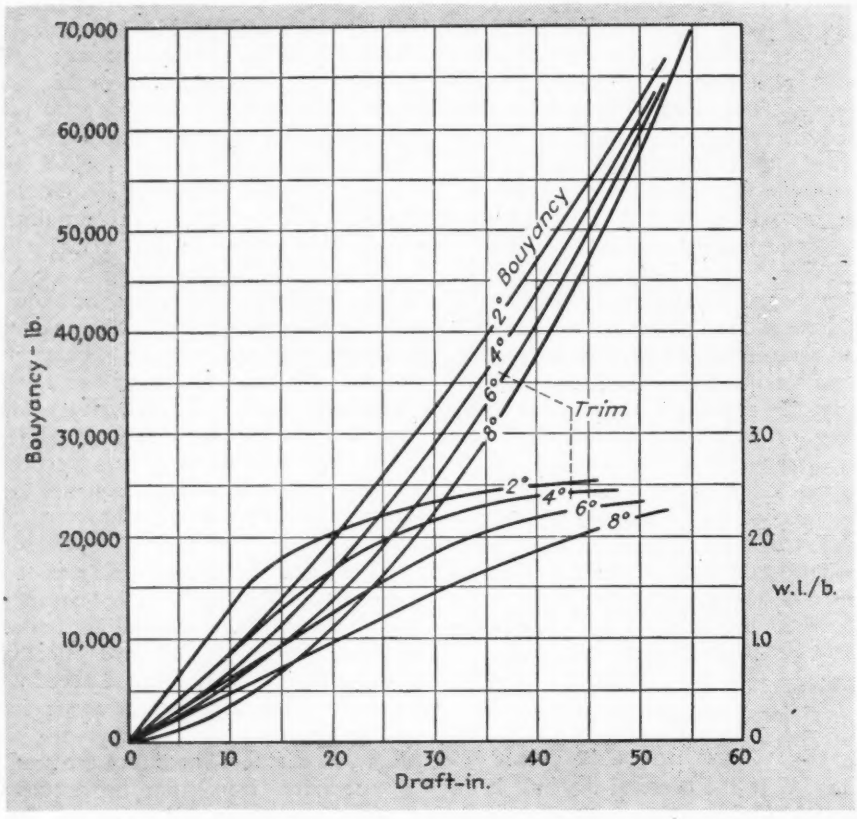


Fig. 9. Buoyancy and wetted length/beam vs. draft for typical hull.

obtain the dynamic lift of the hull, it is first necessary to know the keel line wetted length of the hull in question for various drafts and trims. For convenience, this characteristic is plotted on the same curve with the buoyancy, as shown in Fig. 9. The wetted lengths are obtained by laying out the waterlines, for a given trim and increments of draft, on a profile view of the hull and scaling the distance on each waterline from the step to the keel intercept, as illustrated for the typical case of 8 deg. trim in Fig. 10. So that this figure be nondimensional for entering the charts of planing lift, the values of wetted length, *w.l.*, are divided by the hull beam, *b*, to give the coefficient *w.l./b.* Because of the action of the step, the wetted length for determining planing lift is only that ahead of the main step. This procedure is repeated for each trim being studied, and the curves of *w.l./b.* are plotted as shown in Fig. 9.

With these data plotted, it is possible for any draft to obtain buoyancy in lb. and *w.l./b.* for various values of trim. knowing the ratio of wetted length to beam, the planing lift coefficient is obtained from curves of basic planing data. Curves of basic planing data may be cross plotted from tests made by the NACA Tank[2] and are available for

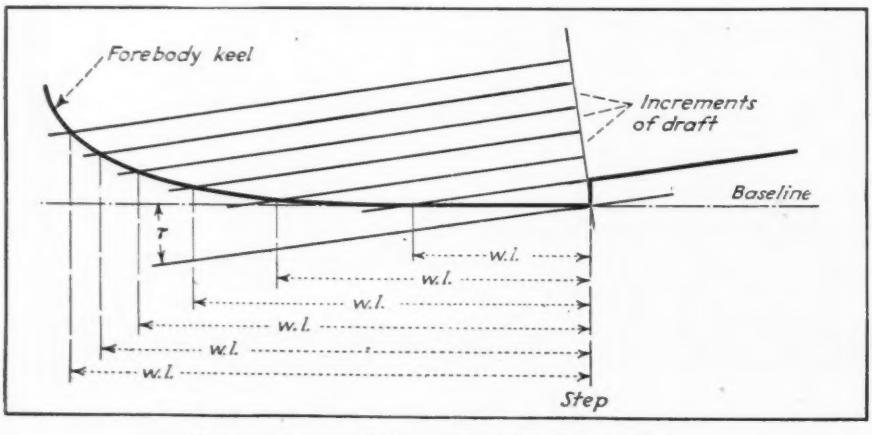


Fig. 10. Determination of hull wetted length vs. draft

0, 10, 20, and 30 deg. deadrise. Intermediate angles of deadrise can be obtained by interpolation, as in Fig. 11 for 22½ deg. deadrise used in the example to follow.

Table II shows the form that has been prepared for making the integration. The gliding speed, v_g, is determined by multiplying the stalling speed by 1.10. The lift coefficient for glide is determined and the ratio of lift to drag, L/D ratio, is obtained from the wind tunnel curves using ½ ground effect. With L/D known the flight path angle is,

$$\theta = \cot^{-1} L/D \tag{29}$$

where θ is the flight path angle. The sinking speed is then,

$$v_s = v_g \sin \theta \tag{30}$$

where v_s is the sinking speed and v_g is the glide speed. With these data determined, the step-by-step integration can be started. Starting with assumed increments of draft, the integration proceeds until the sinking speed v_s becomes zero or negative. Quite frequently, when approaching zero sink, it is advisable to decrease the increment of draft for better accuracy.

For the average draft in in., *w.l./b.* and buoyancy are read from Fig. 9 that has been previously prepared for the hull in question. With *w.l./b.* known, the planing lift coefficient, C_{L_p} is obtained from the curves of basic planing data for the deadrise in question. The dynamic or planing lift is,

$$L_p = \frac{\rho}{2} C_{L_p} b^2 v_g^2 \tag{31}$$

where L_p is the dynamic lift in lb., ρ is the density of water (1.989 slugs per cu. ft. for sea water), b is the beam of the hull in ft., and v_g is the glide speed in ft. per sec.

The planing lift, L_p and the buoyancy, B, are added to give the total decelerating force in lb., which from Newton's law is,

$$(L_p + B) = \frac{w}{g} a \tag{32}$$

Since $(L_p + B)$ is not a constant force, the incremental expression is written,

$$(L_p + B) = \frac{w}{g} da \tag{33}$$

where da is the increment of deceleration and,

$$da = (L_p + B) \frac{g}{w} \tag{34}$$

in which $(L_p + B)$ is the decelerating force in lb., g is the acceleration in ft. per sec. squared resulting from gravity,

[2] Shoemaker, James M., *Tank Tests of Flat and V-Bottom Planing Surfaces*, NACA Technical Note No. 509, 1934.

and w is the total gross weight in lb.

Letting v_1 be the sinking velocity at the beginning of any interval and v_2 the velocity at the end of such interval, the average velocity, v_a, will be,

$$v_a = \frac{v_1 + v_2}{2} \tag{35}$$

and the increment of draft, ds, will be,

$$ds = \frac{v^2_1 - v^2_2}{2\,da} \tag{36}$$

Hence, the final speed for any increment will be,

$$v_2 = \sqrt{v_1^2 - (ds \times 2da)} \tag{37}$$

Proceeding in this manner, step-by-step, the final speed reduces until it reaches zero or becomes negative. At this point the integration is stopped. These data are plotted as shown in Fig. 12. The value v_s is then plotted versus draft to obtain draft for zero sink. The increments of deceleration, da, are plotted against average draft and at the draft for zero sink the maximum deceleration is obtained.

Example Solution: To illustrate the procedure, the characteristics of a typical flying boat as specified in Table III are used.

It is assumed that the buoyancy and wetted length characteristics for this airplane have been determined and are as shown in Fig. 9, and that the planing lift coefficients, C_{L_p}, are taken from Fig. 11, which has been obtained for 22½ deg. by interpolating the basic planing data.

The integration is performed step-by-step as illustrated in Table II for this example.

Headings at the top of the table are filled in, and it will be noted that this calculation is for a landing trim at contact of 8.0 deg. The aerodynamic characteristics are obtained from wind tunnel curves that have been corrected for ground effect, as discussed in *Takeoff Analysis For Flying Boats and Seaplanes,* Aug. 1944 AVIATION, except for these computations, average ground effect rather than full effect is used because the airplane is approaching the ground from free flight and is not fully acted upon by the ground until actual contact is made. Given a maximum lift coefficient, $C_{L\max}$, of 2.0, the stalling speed, V_{stall}, is computed,

$$V_{stall} = \sqrt{\frac{G.W.}{.001189 \times C_{L\max} \times S}} \tag{38}$$

Table III—Characteristics for Exemplary Flying Boat

Item	Given
Gross weight, lb.	41,500
Wing area, sq. ft.	1,780
Wing loading, lb./sq. ft.	23.3
Beam, ft.	10.5
Deadrise angle, deg.	22.5
Flaps at Landing, deg.	40
$C_{L\max}$	2.0
L/D glide	9.1

Table IV
Determination of Deceleration Time

Total S in.	da ft./sec.²	dv ft./sec.	dt sec.	Total Time sec.
0				0
	2.51	.10	.040	
6				.040
	13.10	.28	.021	
9				.061
	24.50	.54	.022	
12				.083
	39.60	.96	.024	
15				.107
	56.75	1.51	.027	
18				.134
	69.80	1.10	.016	
19.5				.150
	77.0	1.44	.019	
21.0				.169
	86.1	2.21	.026	
22.5				.195
	94.5	3.76	.040	
23.6				.235

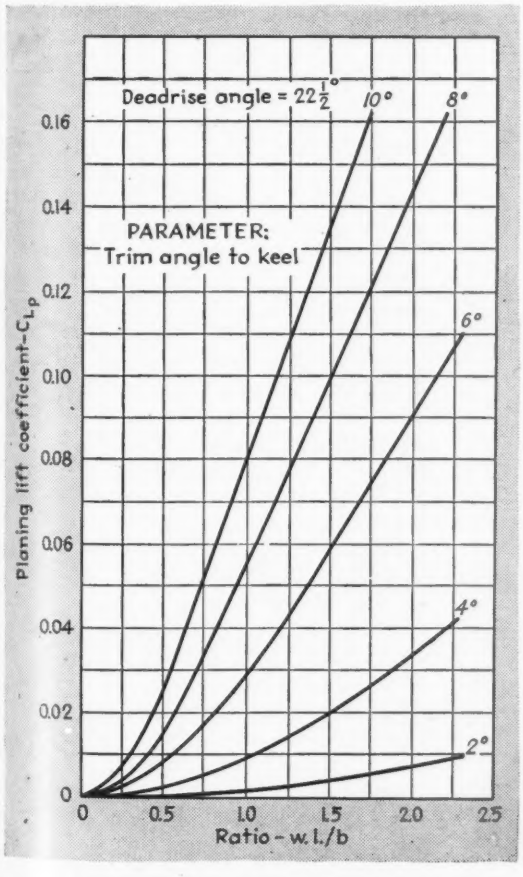


Fig. 11. Plots of planing lift coefficient vs. wetted length/beam—22½ deg. deadrise.

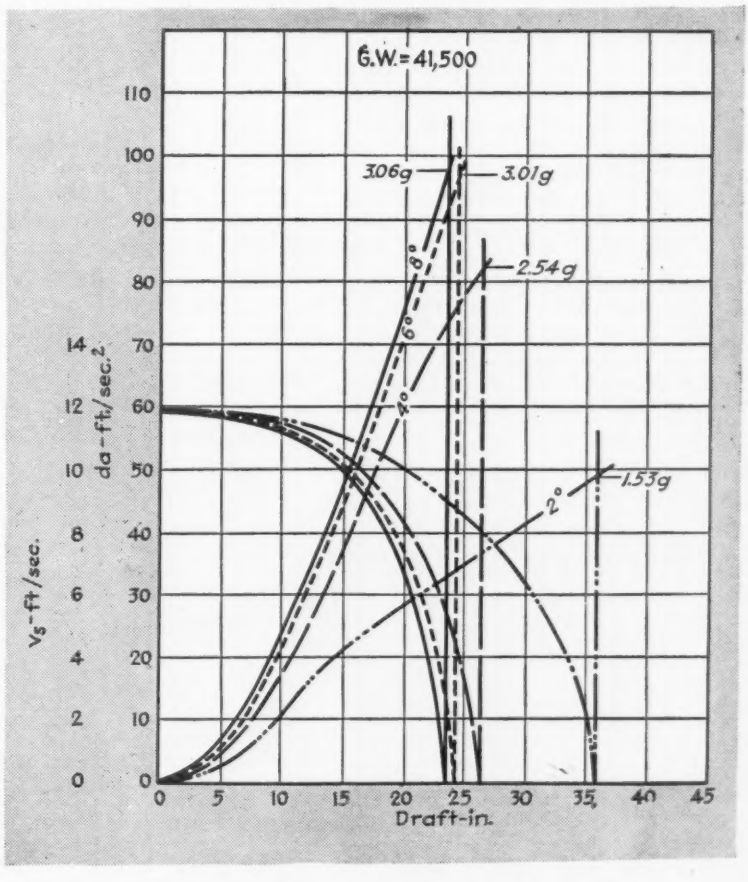


Fig. 12. Impact curves of sinking speed and acceleration vs. draft for contact trims of 2, 4, 6, and 8 deg.

where V_{stall} is in ft. per sec., G. W. is the gross weight in lb., .001189 is $\rho/2$ for air, and S is the wing area in sq. ft., and for the example,

$$V_{stall} = \sqrt{\frac{41{,}500}{.001189 \times 2.0 \times 1{,}780}} = 99.1\,fps. \quad (39)$$

The glide velocity, v_g, is 10% above the stall speed,

$$v_g = 99.1 \times 1.1 = 109\ \text{fps}. \quad (40)$$

and the gliding C_L is,

$$C_{L_{glide}} = \frac{41500}{.001189 \times 1{,}780 \times (109)^2} = 1.65 \quad (41)$$

With the glide C_L obtained, the aerodynamic drag coefficient, C_D, using $\frac{1}{2}$ ground effect, is obtained from the aerodynamic curves, which in this case we assume gave a C_D of 0.181, giving the ratio of L/D_{glide} of 9.1 as stated in Table III. The flight path, θ, is then defined as the angle whose cotangent is the ratio of L/D,

$$\cot 6.25\ \text{deg.} = 9.1 \quad (42)$$

Therefore,

$$\theta = 6.25\ \text{deg.} \quad (43)$$

The vertical sinking speed, v_s, is the gliding speed multiplied by sin θ,

$$v_s = 109 \times .1088 = 11.9\ \text{fps}. \quad (44)$$

The integration is started by assuming increments of draft as shown in the column of "Total S" of Table II. Because of the slow rate of deceleration initially this increment can be rather large at first, For example, the first increment is taken as 6 in. and then in four steps of 3 in. each. In the Col. 2 the increment of draft, *ds*, in ft., is tabulated and the average draft in in. is put in Col. 3. For the average draft of each increment in Col. 3, the ratio of wetted length to the beam, *w.l./b*, and total buoyancy, *B*, is determined for the contact trim of 8 deg. from Fig. 9 and tabulated in Cols. 4 and 7, respectively. Using the value of *w.l./b* in column 4, the planing lift coefficient, C_{L_p}, is obtained from Fig. 11 at a trim of 8 deg.

This value of C_{L_p} is tabulated in Col. 5, from which planing lift, L_p, may be computed in Col. 6. By adding Cols. 6 and 7, the total decelerating force in lb. $(L_p + B)$ is obtained and listed in Col 8. From eq. (34), the increment of deceleration, *da*, can be computed and then accordingly entered in Col. 9.

Since the sinking speed at the start of each increment of draft is known, the final speed, v_2, at the end of the increment can be computed from eq. (37). For simplicity, the radical sign is removed by squaring both sides and a column (11) of v^2, is then added. In this manner $ds \times 2\,da$ in Col. 10 can be subtracted from the initial speed squared to get the final speed squared. This final speed, in turn, becomes the initial speed for the next increment. This step-by-step computation is continued, reducing the increment, *ds*, towards the end of the integration to give better accuracy, until the final speed becomes zero or negative.

The integration is then plotted as shown in Fig. 12 where v_s is plotted versus total draft of Col. 1 and *da* is plotted versus average draft of Col. 3. The acceleration in ft./sec.^{2}, where v_s is zero, is the maximum impact acceleration and may be converted to *g*'s by dividing by 32.2 ft./sec.^{2}, which is noted to be 3.06*g* for the example case of 8 deg. trim. Without listing the actual integrations, which are similar to the one illustrated, the curves of v_s and *da* versus draft for contact trims of 6, 4, and 2 deg. are also plotted on Fig. 12 for illustration.

Total time required from contact to the point of maximum deceleration can be easily computed if this information is desired. Table IV illustrates this computation for the example shown in Table II.

From the laws of rectilinear motion,

$$a = dv/dt \quad (45)$$

Hence, the increment of time, *dt*, for any increment of draft, is the change in velocity divided by the acceleration.

$$dt = dv/a \quad (46)$$

Since the initial and final velocity is known for each increment of draft, the change in velocity is known. Because *da* in Table II is the average deceleration for the increment it is divided into the change in velocity and the time, *dt*, for the increment is solved. Adding these times gives the total time shown in the last column.

Applications of the Impact Integral: Using the method of the impact integral, the isolated effect of wing loading on impact acceleration can be determined. Using an actual case, an airplane originally designed for 26 lb./sq. ft. wing loading indicated a maximum impact acceleration of 3.19 *g* at 8 deg. trim. This airplane had been designed for 6 g at yield and had been completely satisfactory from a strength standpoint in varied types of service operation, the additional factor of 2.81 g, (6.00–3.19) being adequate to allow for rotational acceleration, rough water, and general pilot technique.

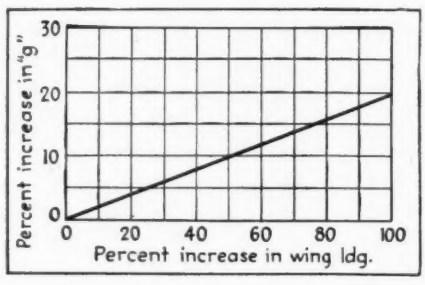


Fig. 13. Increase in impact acceleration with increase in wing loading—initial condition W/S = 24 to 26 lb./sq. ft. and 6.0 g at yield.

Same design, when later reworked for a wing loading of 41 lb./sq. ft., was not satisfactory even though the hull had been reinforced to give 6.0 g at yield for the new gross weight. When an impact integration was made it was found that the maximum impact acceleration, with everything held constant except increased wing loading, had increased to 3.92 g. This indicated that an additional 0.73 g was absorbed in going to the higher wing loading, cutting the margin from 2.81 g for contingencies to 2.08 g. The hull should have been redesigned to a factor of 6.73 g at yield when the wing loading was increased from 26 to 41 lb./sq. ft.

Subsequent reinforcement to meet this figure resulted in satisfactory strength. Fig. 13 shows the average percent increase in g at yield for increase in wing loading, assuming a basic condition of 6.0 g for a wing loading of from 24 to 26 lb./sq. ft. In any particular case, however, the actual integrals should be completely computed to account for slight variations in the specific parameters involved, particularly if the initial design condition is not within the assumed basic condition of Fig. 13.

In addition to determining the isolated effects of wing loading, it is possible to rapidly obtain analytical variations of other parameters. For instance, in Fig. 12 it is noted that for a given condition, the impact acceleration varies from 1.53 to 3.06 g in varying the contact trim from 2 to 8 deg., pointing out appreciable advantages for landing at low hull trims in certain conditions. In a similar manner, the effect of deadrise angle may be studied for a specific application or the flight path and transition required to keep the deceleration to given value can be computed.

In effect, this inherently simple, analytical procedure offers designer an opportunity to tie down, at least qualitatively, many of the heretofore perplexing variables associated with the landing phenomena. With the application of other known quantities—specific aerodynamic transition characteristics, wave velocity, and contour—it is possible to derive specific quantitative calculations for any desired design consideration.

Concluding part of this series will be presented next month.

Stretch-Forming Plus Impact Banishes Joggling Problems

By **DOUGLAS HODGES,** *Douglas Aircraft Co., Long Beach, Calif.*

By preventing irregularities and permitting closer tolerances in formed and extruded sections after bending, ingenious attachment to punch press has reduced rejections of these critical parts to 1 percent.

Mass production and consistently close tolerances have revealed the need for stretch forming many parts which had been troublesome on rolls, hydraulic presses, and hammers. Although stretch forming has developed rapidly, many process men hold that greater developments will unfold in the near future.

The Long Beach plant of Douglas Aircraft Co. found novel uses for stretch forming on the A-26 Invader as well as on the Boeing-designed B-17. Particularly on bulkhead caps and panel stiffeners of the A-26 wing has the use of stretch forming supplanted the use of rolls and hammers. Moreover, the forming of these very critical parts of the Invader's wing has revealed a new type of stretch—an operation which combines impact with stretching.

At the outset of the tooling program, more than an ordinary manufacturing problem was presented by the wing. Laminar in design, its construction depended upon the efficacy of 50 bulkhead caps and 158 hat section formers. The hat sections followed the wing contour and attached to doublers at front and rear spar. At these points the formers had a decimal dimensioned joggle. The hats were located at approximately 8 in. intervals and consequently carried a great portion of the wing load. They were varying in length, some being 28 in., others as long as 45 in. Almost without exception the hats were 1¼ in. in height. They were roll-formed of 24 ST Alclad with thickness varying from .032 to .091. It was clear that all contouring would have to be done in SW condition.

In addition to the problem of holding close tolerances on the general contour of the part there were more acute problems to cope with. A joggle 2½ in. from each end must be held to a tolerance of ±.010.

Making the parts on the stamping machines we had hitherto used had been unsatisfactory because tolerances could not be held under ±.065, except for short formers. Parts which were under 20 in. long had been satisfactory because less error accumulated where no multiple joggles or flattened areas appeared. The short hats would remain on the hammers. But the C-flanges on the long formers could never be reformed by the direct impact of a male punch. Therefore it became feasible to create a line separating one method of manufacture from the other—with the length of the hats serving as the determinant.

Although the shop had made an assortment of parts containing joggles, there had never been a demand for such critical parts held to such close tolerances. Furthermore the joggles heretofore had been beaten laboriously into the metal with mallets and held fast with steel pads. For the shaping of a set of formers which would comprise more than 300,000 critical parts, a more efficient method of fabrication and tooling was required.

It was necessary to add impact to stretch forming. After the problem of drawing a joggle into the metal there arose a worse problem—a general use of flattened areas along the flange of the hat section. These C-flanges must be flattened in order to accommodate a juncture with a doubler or an angle. In some areas it was not only flattened but also joggled up to clear the doubler. Impact was required while the metal was on the stretch forming machine because a set of punch press dies for the irregular joggles and contours would slow down the entire mass production schedule.

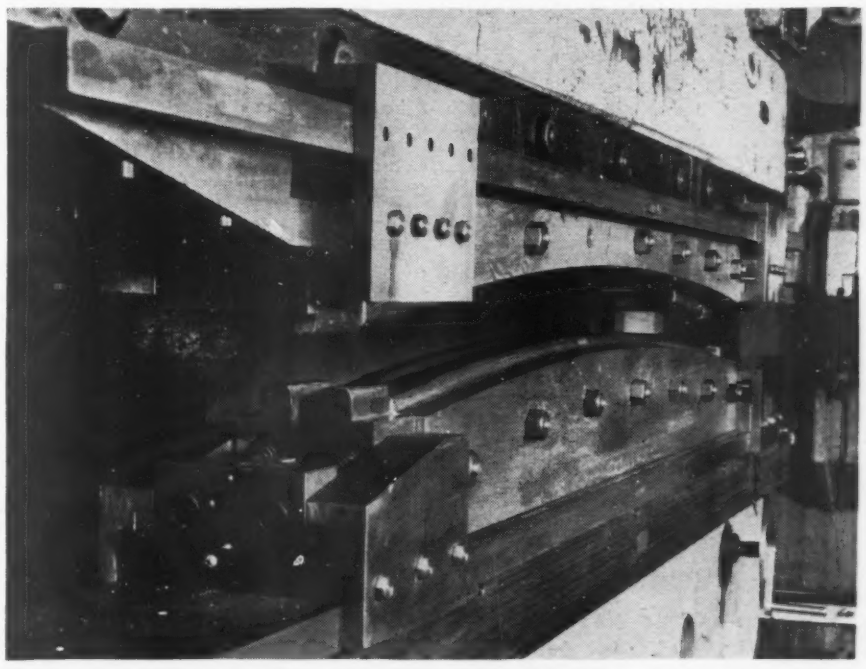


Fig. 1. Die for hat formers is set up in die-holder. In foreground is ramp which guides jaw downward and away from centerline.

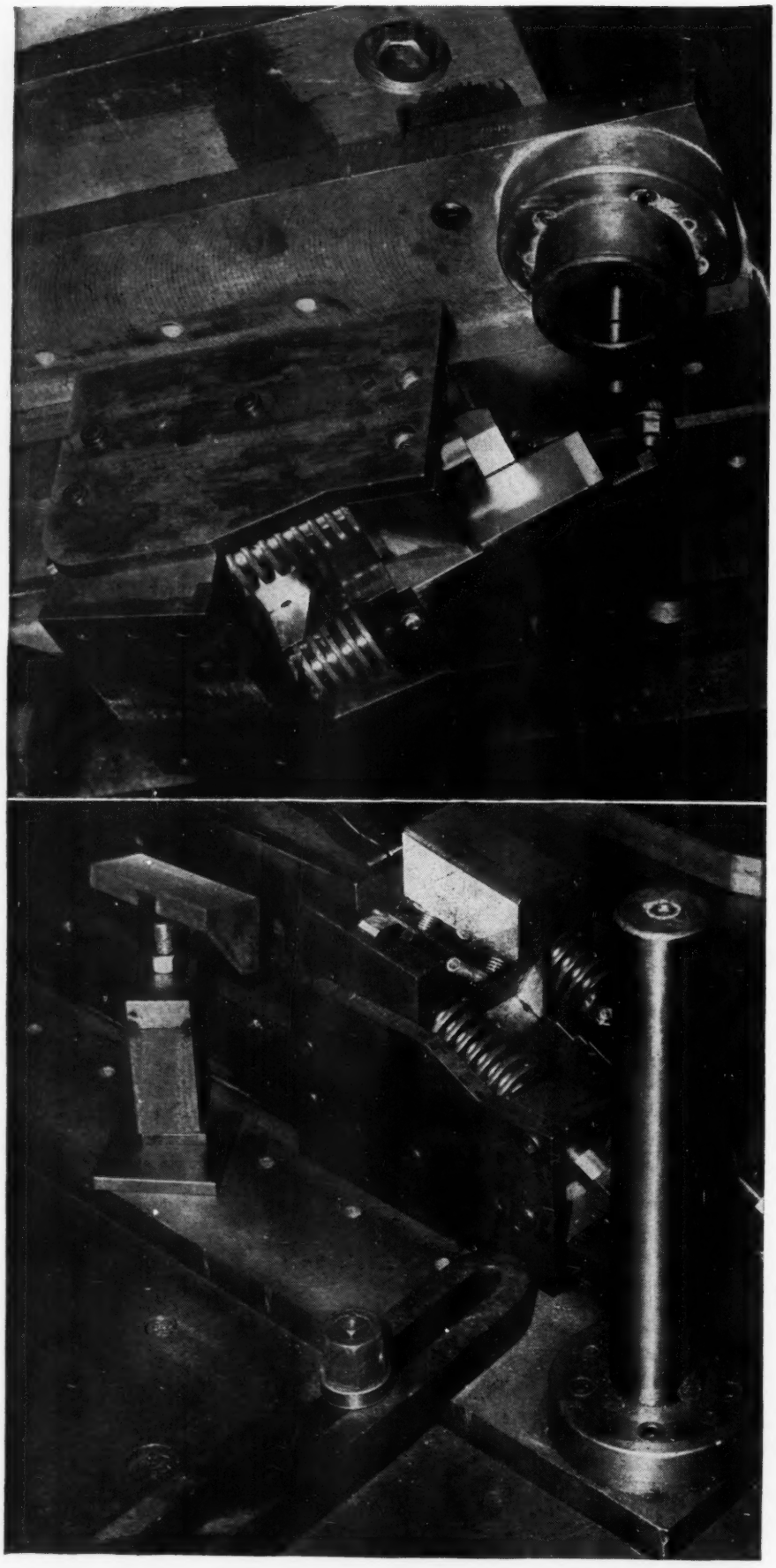


Fig. 2. (Top): Looking up into stretch jaw at one end of die holder. Only two of large springs are shown. Inside the springs are two shafts which guide movement of cam-action jaws. Above: Looking downward into stretch jaw mechanism, with one removable insert taken out to show details of springs. Heavy vertical shaft is guide which fits into socket seen in upper view.

The solution to the problem came with the Douglas development of a stretch die with a male punch and jaws that operated under the single action of a Toledo draw press. To understand this device, first imagine an orthodox stretch form die in which a hat section is set with the crown inverted and with the flanges on the upper side of the die. The die reposes inside a die holder which is 60 in. long. Fastened in the top part of the die holder (Fig. 1) is the mating part of the die, a male punch which delays its impact upon the work until the metal is under approximately 5% stretch.

At the extreme ends of the die holder are the top and bottom parts of an ingenious set of jaws (Fig. 2). These jaws depend upon the action of the draw press, the top or male jaw enclosing the work and contacting the female jaw about 1 sec. before the main impact of the major male punch. The jaws are operated by a cam action with rollers of drill rod to allow the jaws to fall back from the ends of the dies. The jaws are locked before the major punch impact, and they thus provide the stretch action on the work.

The Toledo 795½ triple action press is used only because it is sufficiently large and strong for the work, though single action is all that is required. A power brake can be used instead of the toggle, but the latter is more satisfactory because greater freedom of action for the operator is permitted, since the stroke is greater than in any available 72 in. brake.

With the rise of the punch the jaws retire only a fraction of the travel distance (spring back accounting for the distance) before they disengage the work. By this time the part has been stretched, while the major impact has been made to form the joggles, set the bevels, contour the part, and flatten C-flanges where required (Fig. 3). The entire press action requires less than 3 sec.

Removing the formed part and inserting a fresh one, along with lubricating the work and completing the press action, requires 28 sec. Allowing for changing dies and other items related to job setup, it has been found that the combination stretch and joggle die has a capacity of approximately 950 parts per day (1st and 2nd shifts).

Supplying the line with 158 formers for each A-26 on a fast schedule required the use of the Toledo less than 16 days per month, with none on third shift.

When the part leaves the press it goes to the bench, where an operator immediately checks it against a contour template. Because of an irregularity in material caused by heat treat or other obscure defects, 1% sometimes proves

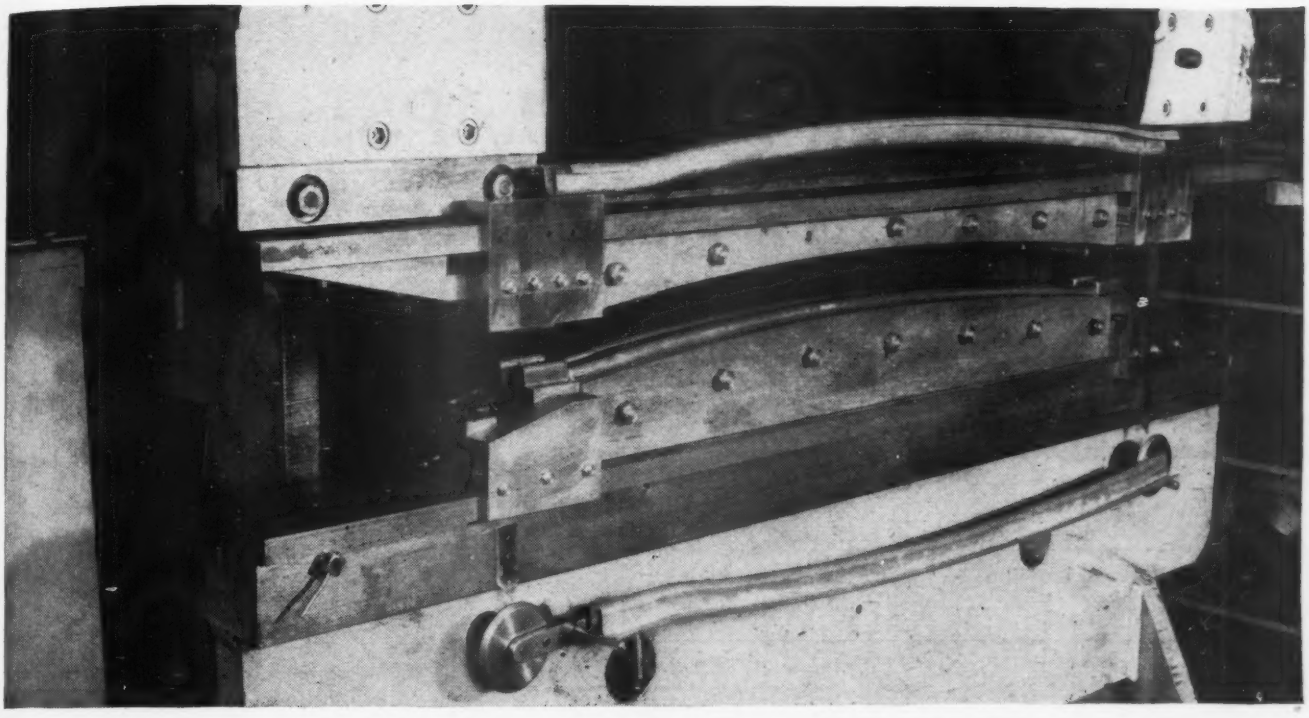


Fig. 3. Completed formers laid at top and bottom of machine after completion by single stretch-impact process.

unusable. After forming, the part is trimmed and scarfed before going to the arbor presses for a final check and straighten. It has lost its SW property by this time, but it can still be worked to correct any contour errors that may have resulted from careless or unavoidable abuse. All dies used for these formed parts are made of Kirksite.

Application of this new type of stretching has proved so satisfactory in the Douglas plants that it was decided to employ impact-stretching even further in solving other A-26 wing problems. There were many bulkhead caps on the wing as long as the formers, indeed in most cases both longer and heavier. These also go on the new process program.

The caps are extrusions, in most cases, and thickness varies from .091 to .250. A few are angles but most are tees with joggles held to ±.010 tolerance. Because of these characteristics heavier jaws are required. Dies of steel, instead of Kirksite, are also required.

Because the Keller proces had proved satisfactory in reducing the hat sections, it was decided to Keller the steel dies for the bulkhead caps also. A Keller template had sufficed formerly, but now such a template would be inadequate. The template was made from the lines layout to pick up the form of the bulkhead. From this was made a detailed mahogany Keller pattern to show joggles and bevels across the horizontal leg of the tee.

The ¼ in. extrusions (Fig. 4) are fully as adaptable to this new principle as the .040 hat sections; they prove to be far more accurate than the parts made with punch press joggle dies.

Despite the rapid action of the Toledo press we find it practicable to locate a No. 10 tooling hole in the standing leg of the tees. By the action of a small solenoid-operated fixture, the fall of the punch releases a prick punch through a bushed hole in the die to mark the location of a hole to be drilled later. This setup is unnecessary in making hat sections because tooling holes in the crown of the hat are located by a small dimple in the metal.

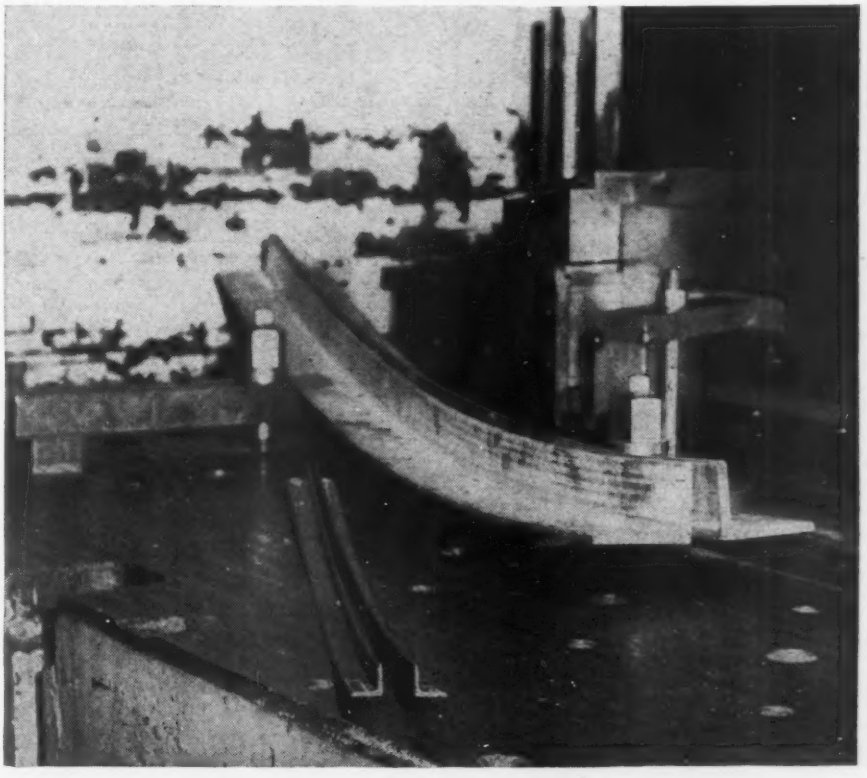
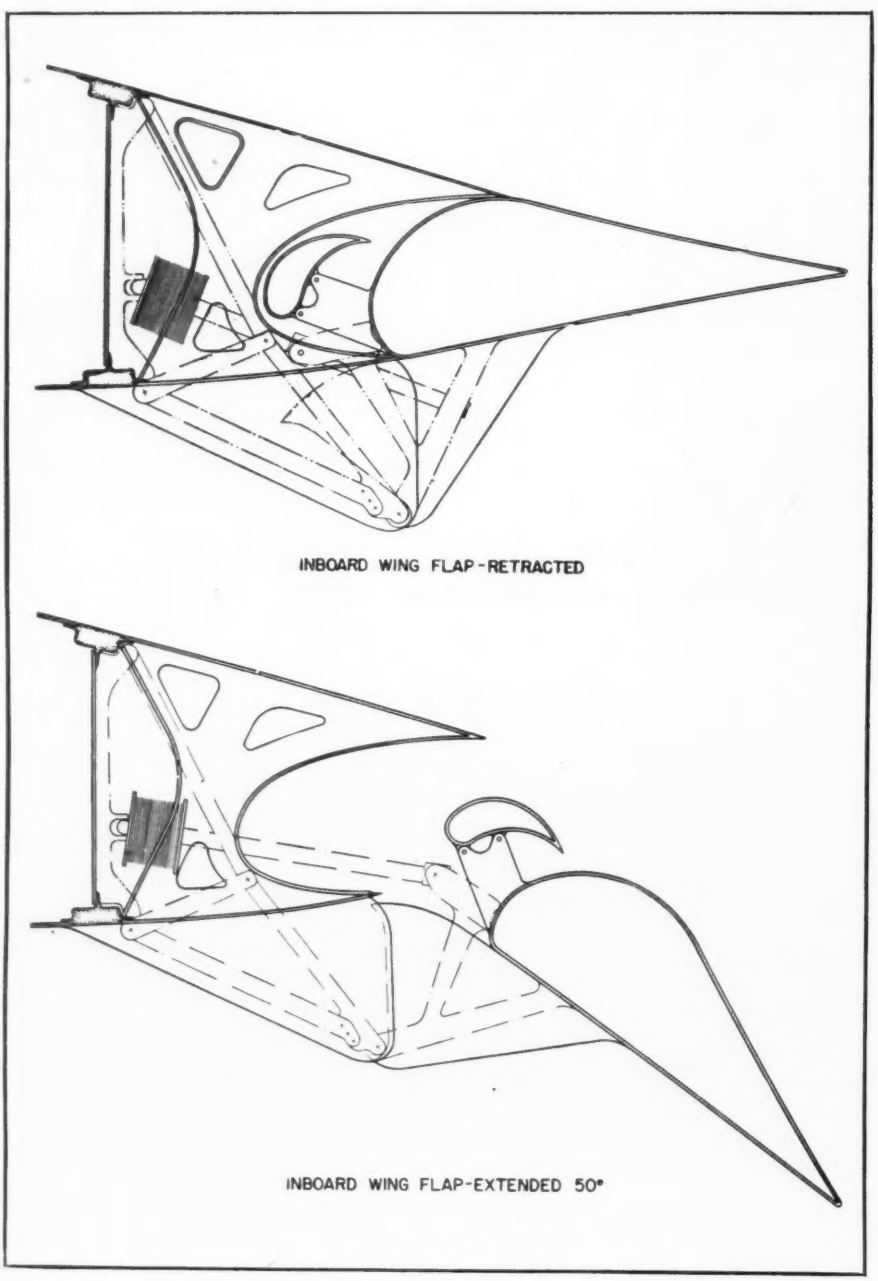


Fig. 4. Two sets of angles, .250 and .125 thick, formed by being set back-to-back in stretch-forming machine jaws. Each set carries a joggle at either end, formed at some time as bending was completed.

NEW TYPE FLAPS LOWER C-74 LANDING SPEED

Details of Douglas craft's novel full-span unit show it employs conventional split-type flap, double-slot flap, and combination aileron-flap, latter bringing new word—ailerflap—to aviation language.



GIVING LANDING SPEEDS 15 percent slower than would be possible with ordinary split-type flaps, new combination double-slotted flaps and ailerons called "ailerflaps" have been incorporated in the Douglas C-74 Globemaster, military version of the DC-7 (see page 108 Oct. AVIATION).

Full span, the new type flaps are built in six segments: Two conventional split-type beneath the fuselage; one double-slotted type on each side extending from the fuselage to normal aileron position; and one "ailerflap" on each side from there to the tips.

The inboard double-slotted units bear some resemblance to those first used on the A-26 Invader (described on page 160 May, 1945, AVIATION).

Outboard ailerflap consists of four parts: A flip; outboard wing flap vane; outboard wing flap segment; and aileron flop, all tied together by hinges and linkage, and controlled by a lever in the pilot's cockpit connected to pilot valve operating a hydraulically-driven winch.

The aileron segment moves as part of the flap in response to flap settings and, in addition, as a standard aileron when changes of position are required from whatever its position is as part of the flap. When raised above, or lowered below, its position as part of the flap, a linkage moves the flip, which is located just ahead of the ailerflap in the upper trailing edge surface of the wing, providing a drag surface forward of the airflow through the double slots of the flap. When flaps are down, the flip moves up as the aileron moves up and also moves down as the aileron moves down.

Landing speed of the C-74 is reduced by about 15 percent by the full span flaps, with the total lift being distributed among the surfaces in the following proportions: Under-fuselage

Detail sketches showing linkage and operation of Douglas C-74 Globemaster double-slotted flaps, which extend from fuselage to "ailerflaps." Linkage extends below wing and is enclosed in fairing. With six such fairings, cruising speed is reduced 1-2 mph., and top speed 2-3 mph., but this is compensated for by weight savings and simplified design.

split flaps, 10 percent; double slotted inboard flaps, 65 percent; and the double-slotted outboard ailerflaps, 25 percent. No appreciable loss in flap efficiency is reported when the aileron segment is actuated for aileron control.

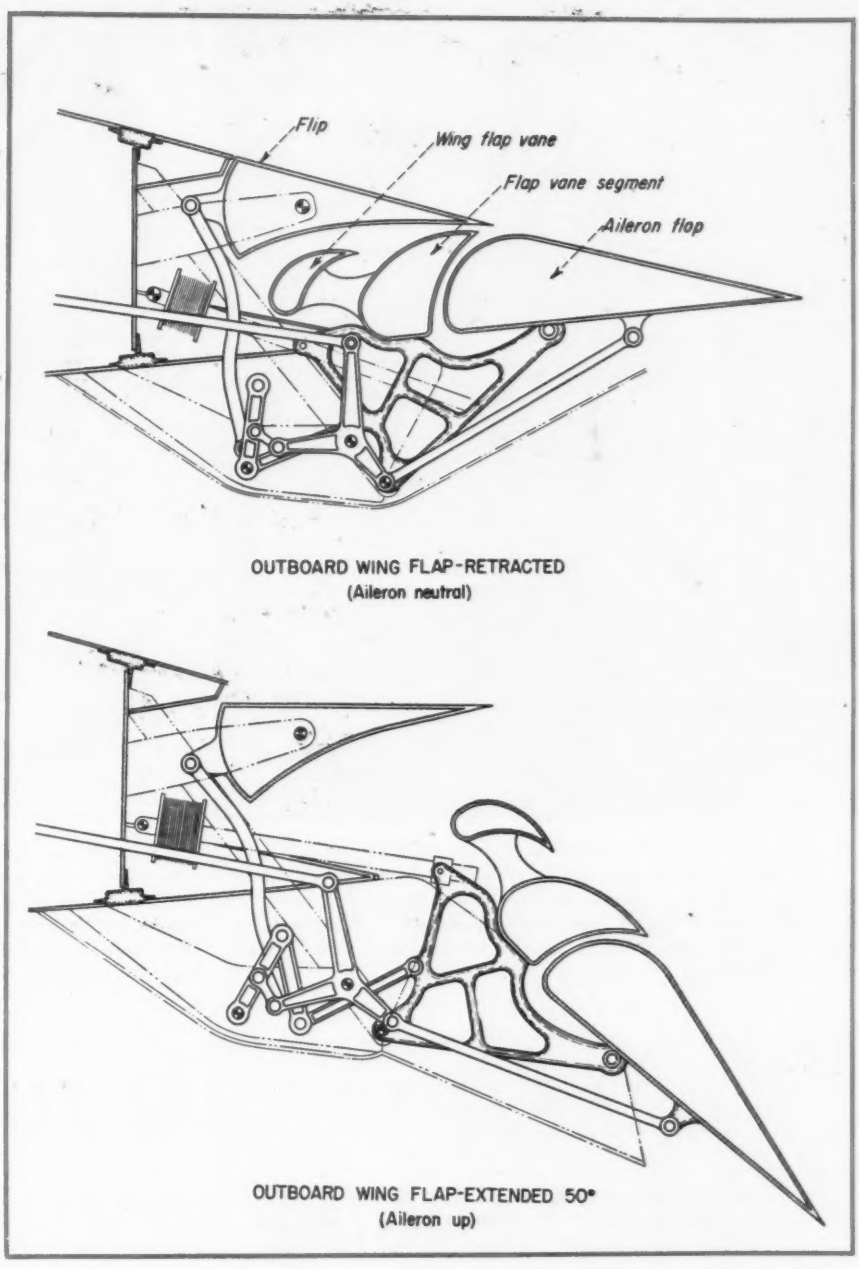
Power is taken from the main hydraulic system, with the winch having a built-in brake that is locked until hydraulic power is applied, to eliminate creeping. A gear train, with a reduction of 80 to 1, drives a drum around which cables are wound and extend, via idler pulleys, to drums on drive screws of the two inboard flap segments.

Outboard segments are driven by smaller, secondary drums on the inboard drive screws, around which are cables extending to drums on the outboard drive screws. Under-fuselage flaps are actuated by means of a linkage connected to the inboard flaps.

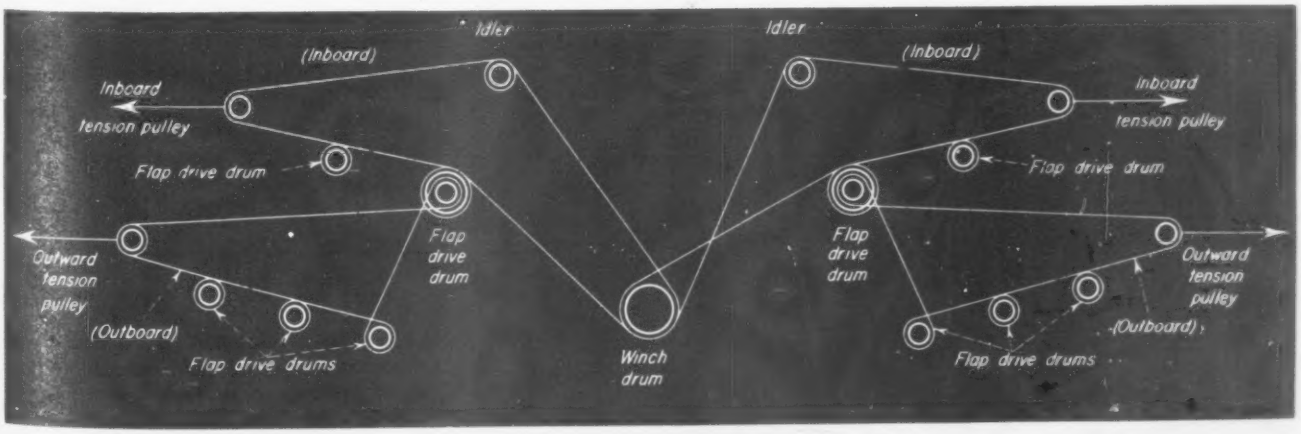
A limit valve, located behind the main drive drum and operated by it, automatically stops the flaps when maximum travel has been reached, and an indicator shows flap position on an instrument in the cockpit. Down and up travel being automatically stopped, it is only necessary for the pilot to watch the position indicator instrument for intermediate flap settings. After completion of the operation, the pilot returns the lever to neutral in order to take advantage of the brake, which will ensure holding the flaps in the desired position.

External placement of flap hinges and fairings imposes a penalty of 2 or 3 mph. at high speed and 1 to 2 mph. at cruising. This was accepted to increase efficiency through a flap of cleaner design and to provide greater hinge and actuating mechanism leverages at lesser weight costs.

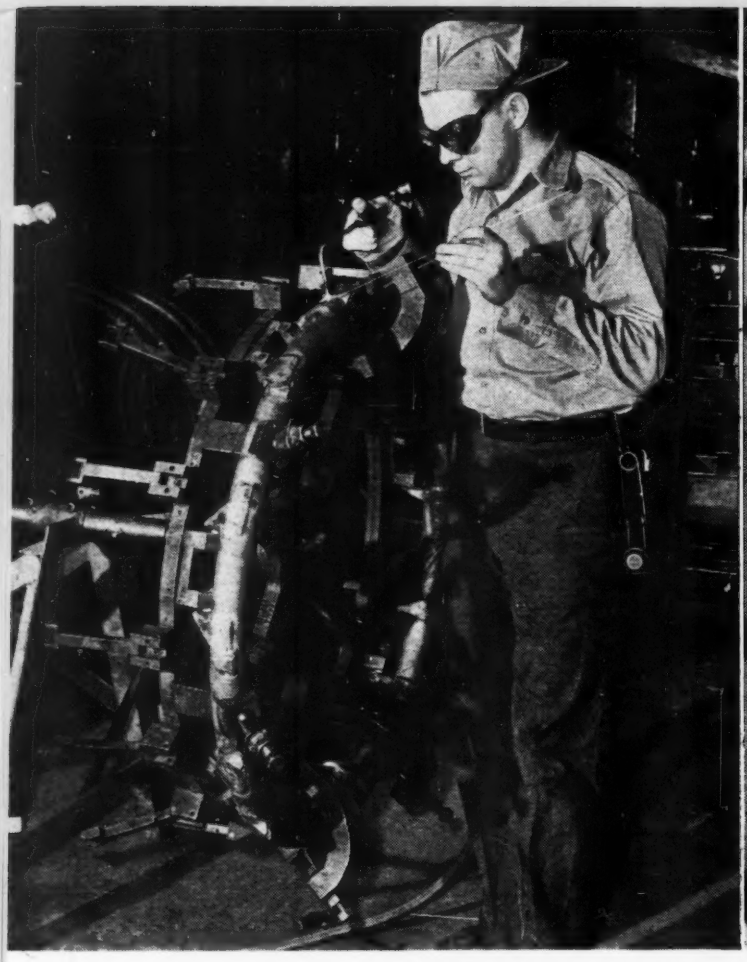
Principal differences in the double-slot feature of the C-74 flaps, over these on the A-26, are rigid attachment of the vane to the flap, and simplification of the operating mechanism.



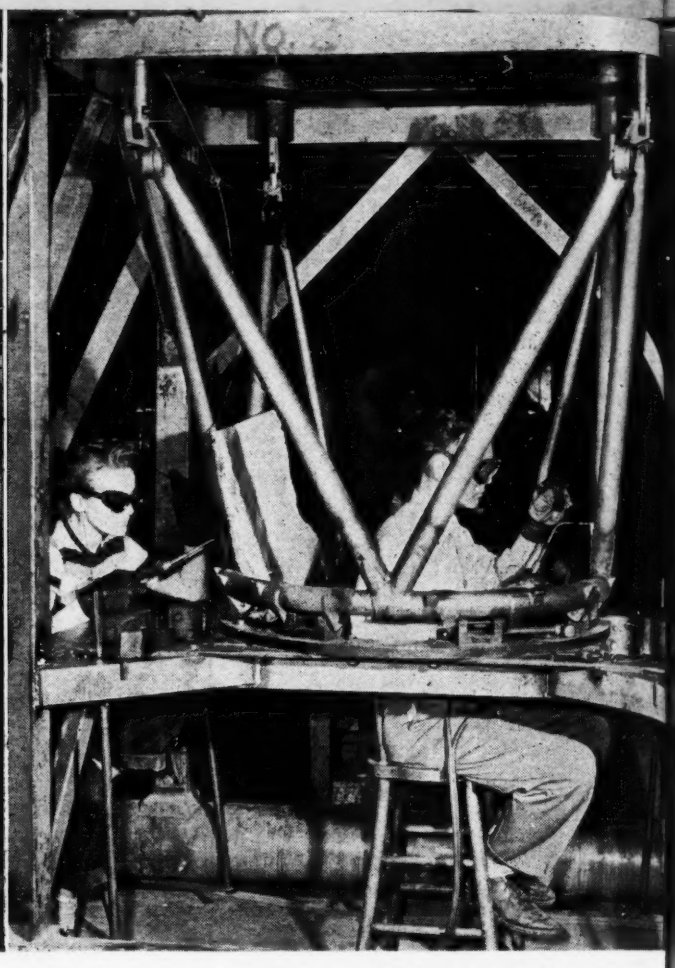
Sketches showing retracted and extended positions of "ailerflap," combination aileron and flap which helps reduce C-74 landing speeds by about 15%. Linkage permits aileron segment to move as flap segment for flap settings and also as normal aileron when such action is required.



Schematic diagram of cable drives from hydraulically-operated winch for inboard and ailerflap segments of C-74 full-span flaps. Under-fuselage split-type flaps are operated by linkage connected with inboard segments.



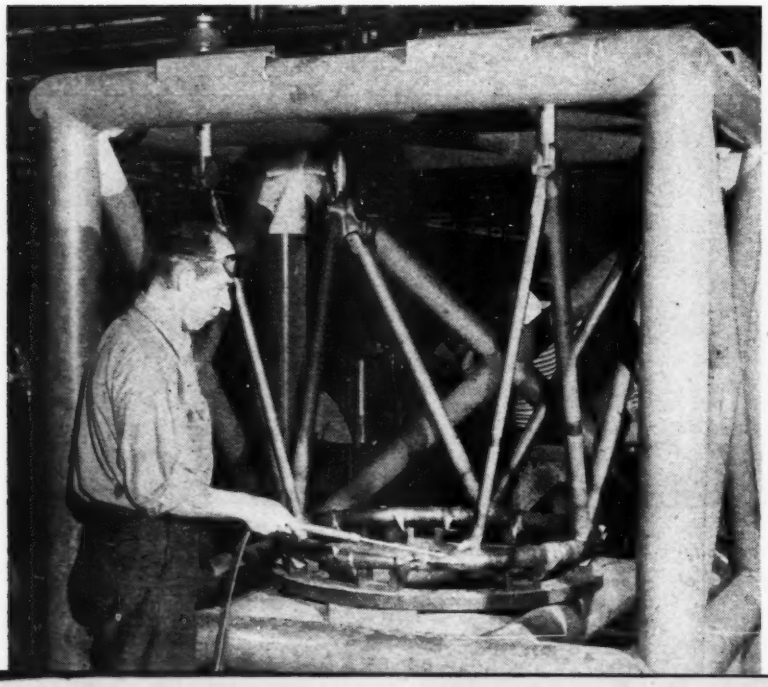
1. Seen here is assembly fixture for engine mount ring of 8630 2¼-in. tubing. Setup man tacks and welds-on Lord mount fittings and clips to serve as attachments for engine shroud. To allow for shrinkage, splice in ring is last point welded, and to avoid warping, the ring is then permitted to cool in the assembly fixture before removal from latter.



2. Ring is then welded to four engine-mount legs. (Previously, in other fixture, two sections of each leg had been assembled and welded to a forging for attachment to firewall in completed assembly.) Horizontal sliding pins, shown at top of each leg detail, hold legs in position and allow for shrinkage. Mount is inspected, sent to sand blast, then Magnafluxed.

THESE SPECIAL FIXTURES SPEED ENGINE MOUNT OUTPUT

By **HARRY MERLE,** *Assistant Superintendent of Unit Assemblies, Columbus Plant, Curtiss-Wright Corp.*



3. Line-up fixture is used after mount is completely welded. With ring held in exact position by pins, worker is lining up position of each leg by applying heat, which shrinks metal slightly in heated area. Legs must also be lined up with four pins at top of fixture, which represent firewall fittings.

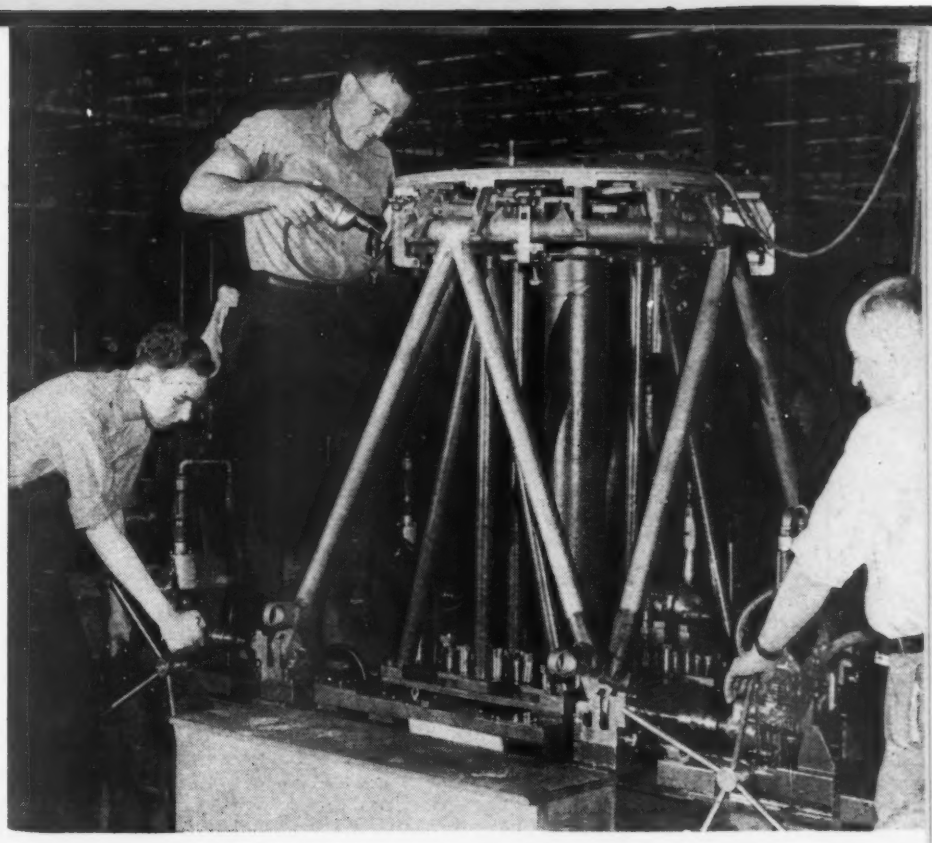
This revealing picture story of a war-born production - boosting process has profit meaning for peacetime fabrication.

WITH CHANGEOVER to the special machining fixtures designed at Curtiss - Wright's Columbus plant, production of SB2C Helldiver engine mounts soared approximately 70 percent.

Adopted by many other aircraft manufacturers, these special fabrication units enable the mount to be located in a vertical position to accomplish all machining more simply and quickly in two fixtures—with precision alignment of work.

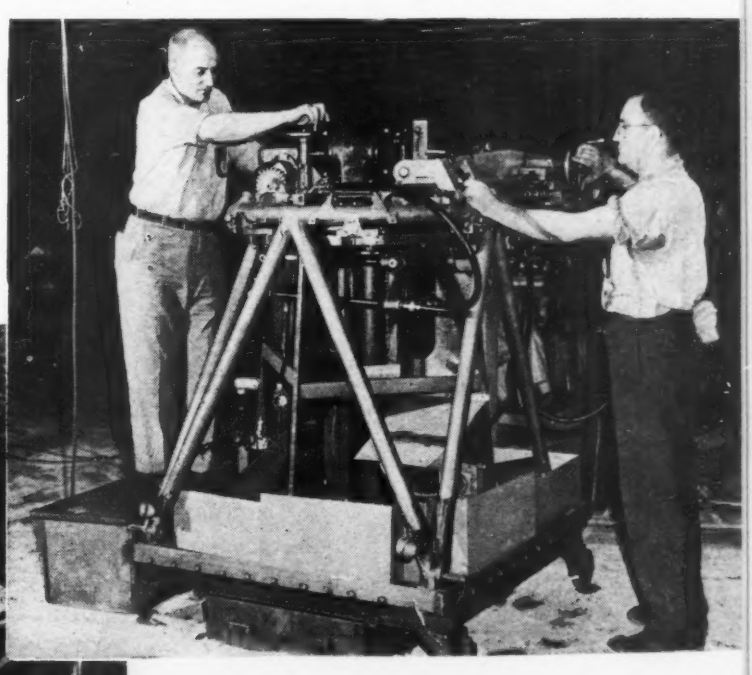
Formerly, the mount was machined by hand operation in a horizontal fixture, using an electric drill and spot facer.

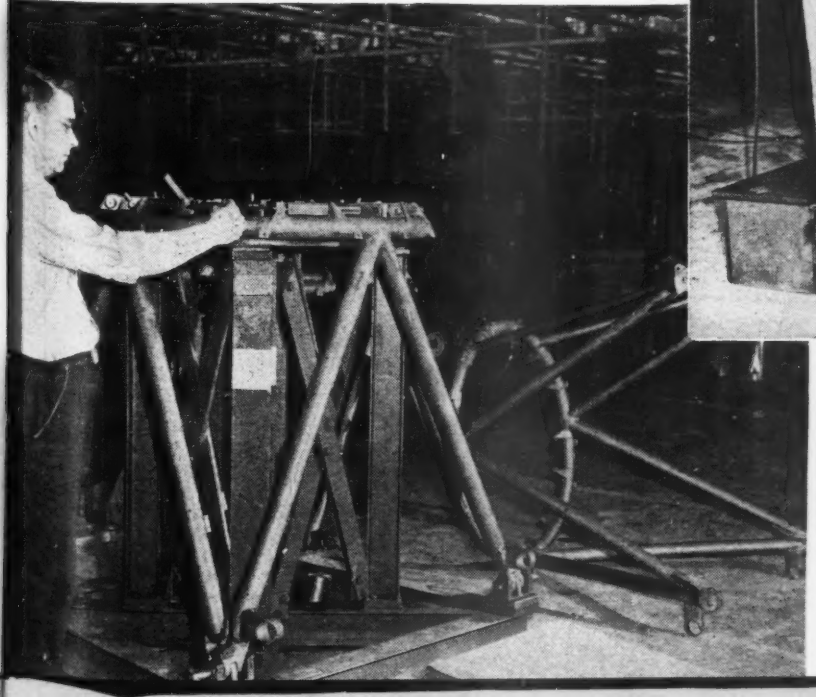
Details of the new production units are shown in the accompanying photographs depicting step-by-step application in the fabrication process.



4. *In first of two special machining fixtures, mount is dropped into position by monorail hoist running length of engine mount line. Legs are clamped to fixture at bottom, aligned so that there is proper edge distance from hole to be drilled. Mount ring is held by four clamps. Detachable top fixture ring, swung into place by hoist after mount has been fitted into fixture, is set in position by slipping over four locating pins. To drill holes in firewall attaching points on legs, four pneumatic hand feed drills are used, each mounted permanently at corner of fixture. Same machine reams with change in bushings. Man in center is drilling holes in clips for engine shroud attachment points, and to insure interchangeability, drill jig for latter is made from same matching plate as shroud tool. Machine coolant fluid runs through to drip pan below fixture, then recircularies. The total drilling time in this fixture is 1 hr.*

5. *In second machining fixture, mount is held by pins in holes previously drilled and at four locating points at fixture base, and ring is clamped at top. Motor on fixture top runs set of standard cutters, which mill to blueprint dimensions, between two parts of each Lord mount attachment point. Completed attachment point is shown at ring center, milled to tolerance of .005. Man at right is using indexing drill for drilling and reaming holes in attachment points. Hose carries coolant fluid; rope and cable (left) are part of monorail hoist. Total time in this machining fixture is 1¼ hr.*





6. *Drilled holes in Lord mount attachment points are checked with inspection gage for proper alignment. Two raised points are go and no-go gages for checking attachment point dimensions. Already checked, firewall attachment points are held in place by pins.*

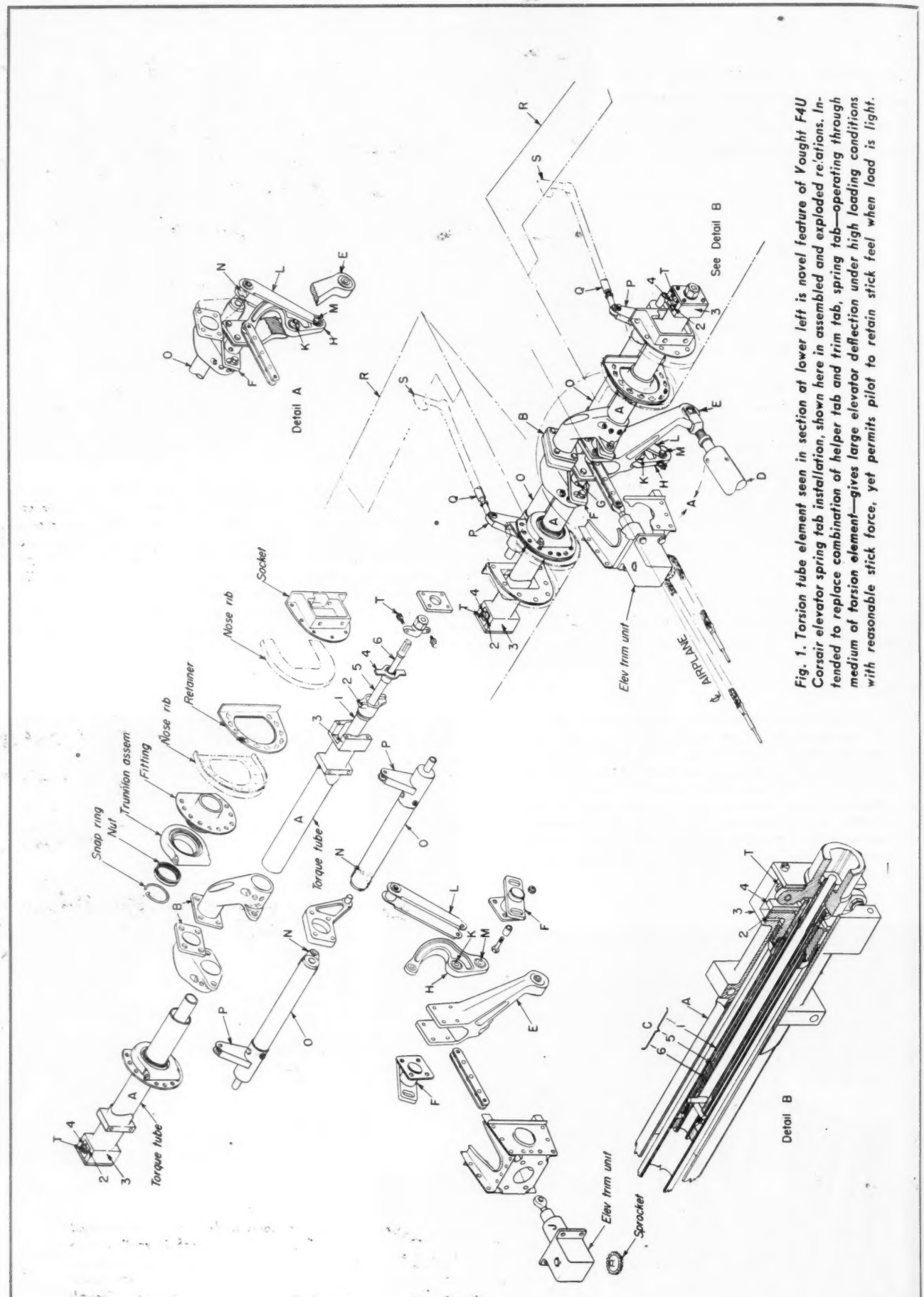


Fig. 1. Torsion tube element seen in section at lower left is novel feature of Vought F4U Corsair elevator spring tab installation, shown here in assembled and exploded relations. Intended to replace combination of helper tab and trim tab, spring tab—operating through medium of torsion element—gives large elevator deflection under high loading conditions with reasonable stick force, yet permits pilot to retain stick feel when load is light.

Torsion-Element Spring Tab Combines High-and-Low Load Efficiency

INTENDED TO REPLACE the helper-trim-tab installation on the Vought F4U Corsair, an effective spring tab and trim unit, featuring an ingenious torsion element, enables pilot to obtain large elevator deflection under high loading conditions with application of reasonable stick force, yet does not materially reduce control forces required under flight conditions where these forces are already light, thus permitting pilot to retain his stick feel.

As presently constituted, the helper tab is always operated with elevator deflection, whereas the spring tab installation is so designed that it will function only when pilot actually needs help.

Fig. 1 (page at left) shows the units of the spring tab installation in assembled and exploded relation. Elevator nose ribs are fastened to retainers carried by the torque tube (A) which is divided in two sections connected by a bridge fitting (B) at locality of attachment of elevator control linkage to a steel torsion element contained within each section of the torque tube. This torsion element (C), shown in section in detail B, is essentially a long spring in the form of a tube concentrically doubled back because of space limitations, and attached to one end of the torque tube section.

To overcome application of a large airload on the elevator, a pull on rod (D) is transmitted to horn (E) attached to the torsion spring tube through collar (F) at point (G), causing the spring tube to twist and give relative movement between it and the torque tube to which it is fixed at one end. A slot in collar (F) limits the motion of the spring element with relation to torque tube. Movement of horn (E) is transmitted to lever (H) through point (K) and thence to link (L) through point (M). Movement of link (L), attached to crank (N) (see exploded relation) causes rotation of jackshaft (O), and arm (P) moves pushrod (Q) which actuates tab (R) through horn (S), giving opposite movement of elevator as a result of the turning moment produced by the tab airload.

Action of the spring tube element is such that aft movement of the stick causes counterclockwise rotation of the element's large or outer section (1) which, being attached to extension (2), immediately contacts torque tube fitting (3) serving as a stop. Twisting of the large section gives a tab deflection proportional to the stick force used—illustrated by the line OA in the force diagram shown in Fig. 2.

This condition also holds true when moving the stick forward up to point B, where tab deflection is approximately 3 deg., beyond which the large section tube extension (2) overcomes the preload force on extension (4) attached to spring tube element intermediate section (5). Preload is applied by screw-and-nut arrangement (T) to spring element inner tube section (6) which is pinned at its opposite end to intermediate section (5).

Since the inner and intermediate tube sections twist more readily than the large outer section, force applied beyond point B (Fig. 2) will result in deflection of only these smaller tubes, along the line BC, to give a large tab deflection for comparatively little application of force—a definite aid in spin recovery.

Normal trim tab operation is obtained by operating lever (H) at its upper end by means of screwjack (J). This does not affect spring tube operation but merely displaces the zero-setting of tab.

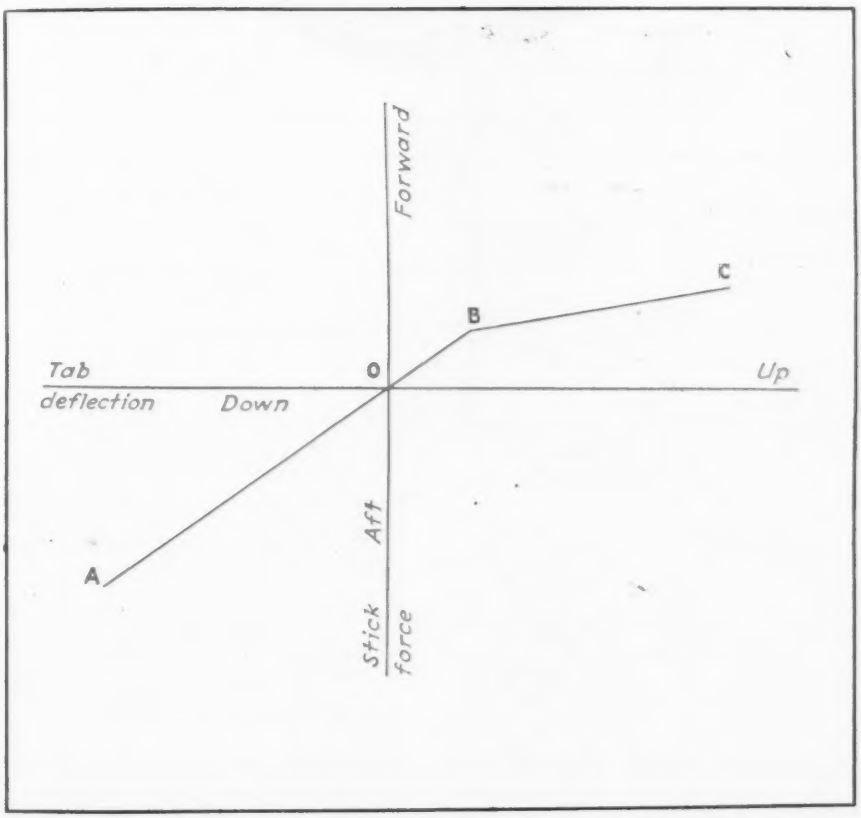


Fig. 2. Diagrammatic representation of stick force required for elevator deflection through action of torsion element in spring tab installation.

Brake Shoe Clearance Adjustment Unit Automatically Compensates for Wear

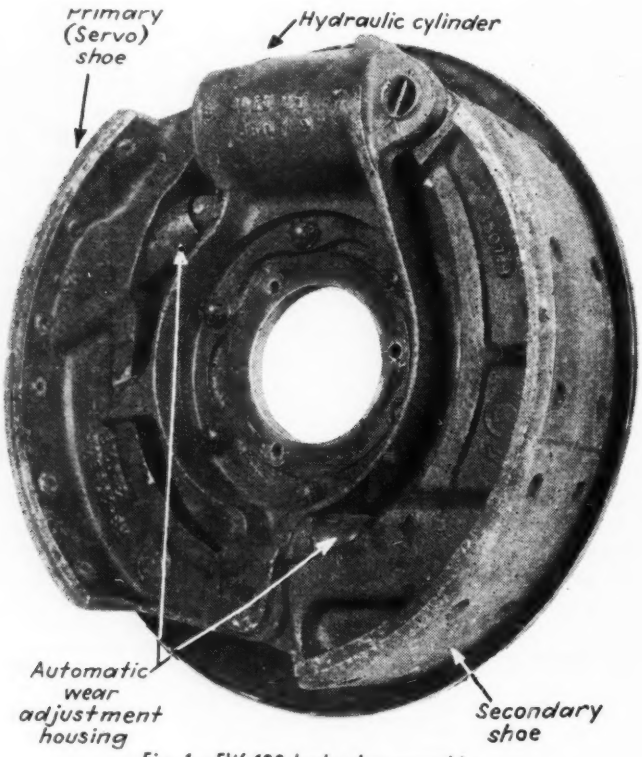


Fig. 1—FW-190 brake shoe assembly.

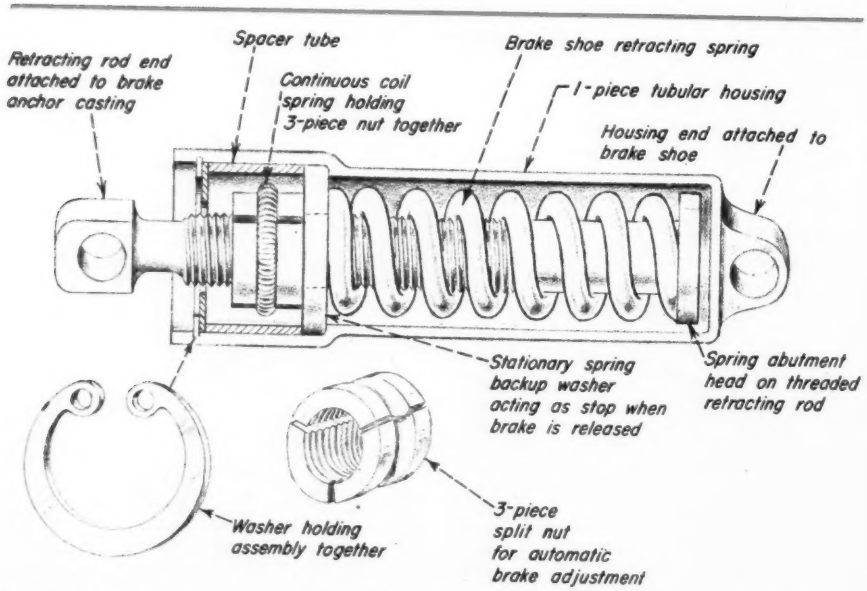

Retracting rod end attached to brake anchor casting
Spacer tube
Continuous coil spring holding 3-piece nut together
Brake shoe retracting spring
1-piece tubular housing
Housing end attached to brake shoe
Stationary spring backup washer acting as stop when brake is released
Spring abutment head on threaded retracting rod
Washer holding assembly together
3-piece split nut for automatic brake adjustment

Fig. 2—Sectional view of constant-clearance brake adjustment mechanism on FW-190. Feature is 3-piece brass nut which automatically expands when device is over-extended as result of brake wear. In operation, the retaining washer pushes against the nut, causing it to expand and seat itself on the following thread. When brake is released, nut acts as stop and prevents spring from pulling brake shoe back to original position. (Staff sketch by Ricker)

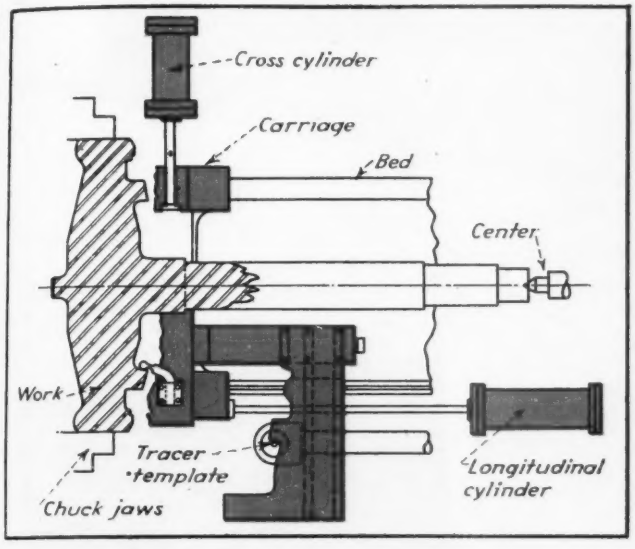
BRAKE ASSEMBLY on the German FW-190 embodies interesting and simple construction details which include a novel and simple automatic adjustment device to insure fixed shoe clearance when the brake is released, thus to provide subsequent brake application at the same pedal position.

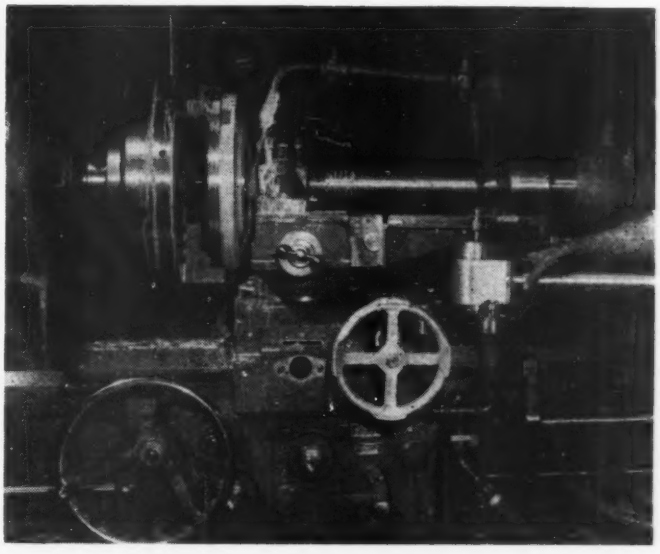
Each brake (Fig. 1) has a hydraulic operating cylinder cast integral with the brake shoe support and anchor. Brake mechanism is of the uni-directional type with primary shoe attached to the operating piston and hinged to the secondary or main shoe, which is anchored to the back end of the hydraulic cylinder. Primary shoe provides a servo action and increases braking capacity for a given foot pressure.

Shoes are made of cast magnesium alloy faced with two strips of metallic alloy having the appearance of sintered iron filings and zinc. Six hollow rivets hold each strip in place. Strips on the primary (servo) shoe are each $5\frac{5}{8}$ in. long, $2\frac{3}{4}$ in. wide, and 9/32 in. thick. Secondary shoe strips are each $6\frac{1}{4}$ in. long. Total braking surface per wheel is approximately 65.3 sq. in. Inside dia. of brake drum is about $11\frac{7}{8}$ in.

Each shoe is equipped with an automatic adjustment device which serves to retract the shoe and maintain a substantially fixed clearance by compensating for wear. As seen in the sketch of the unit (Fig. 2), with application of heavy brake pressures or continued normal brake use, and consequent wearing of the shoe, the housing, as it moves to the right when following the shoe, draws the retaining washer into contact with the split brass nut on the fixed retracting rod, and if the unit is pulled more than half the thread pitch (32 tpi.) it will expand and seat itself on the following thread. When the brake is released, the nut acts as a stop and prevents the retracting spring from forcing the shoe back to its original position, since the force of the spring is not sufficient to expand the split nut.

PLANT PRACTICE HIGHLIGHTS



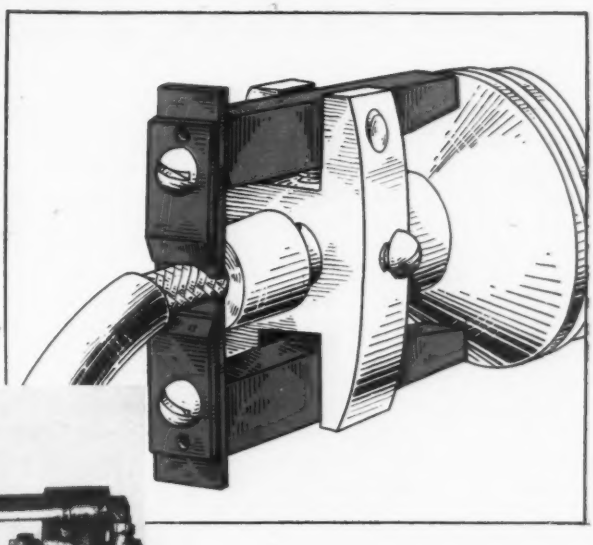


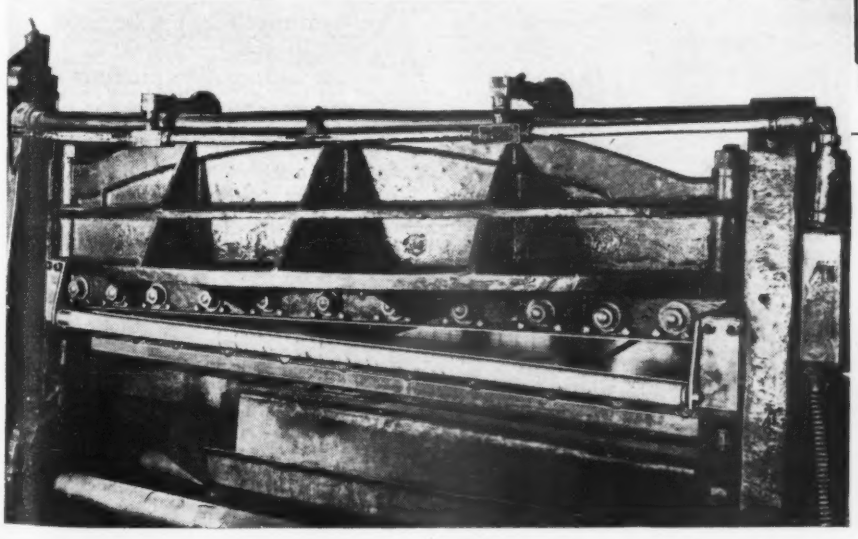
Cam-Controlled Hydraulic Lathe Feed Speeds Work, Improves Finish

• Guided by template of ⅛ in. sheet steel which operates a control roller, two hydraulic cylinders operate feeds of lathes equipped by Turchan Follower Machine Co. Reproduction of complicated contours is so accurate that surfaces are free from ridges and as smooth as if grinder finished. Diagram indicates simplicity of installation.

Stripper Errors Curbed By Adjustable Stop

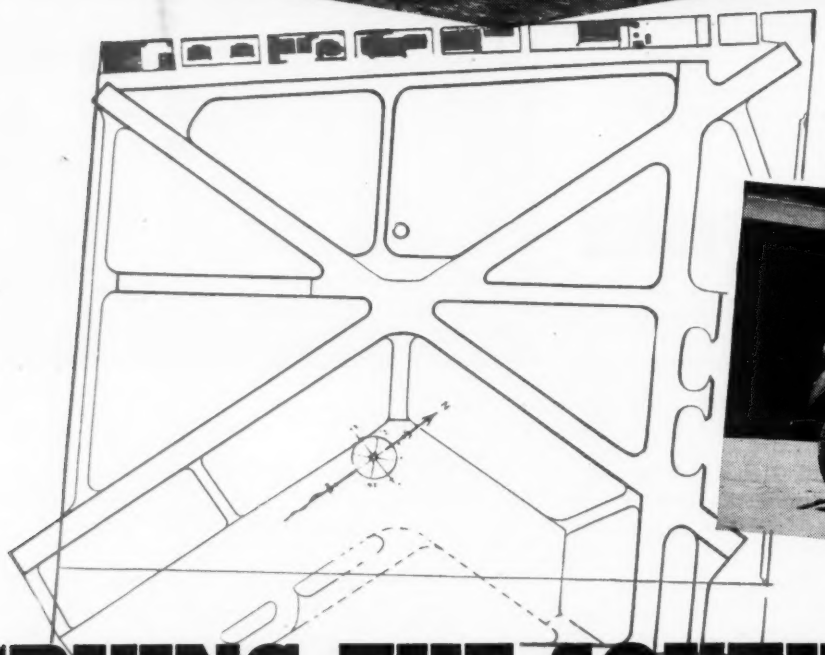
• With addition of adjustable stops behind stripper blades used in removing shielding from cables, Martin's Omaha plant has almost eliminated losses caused by old method where operators had to guess depth of insulation. After stops are set for a specified cable dia., it is impossible to cut more deeply, result being that losses have dropped from 50 percent to nothing. Moreover, 1,500 man-hours per year are saved through eliminating reworking of damaged cable.

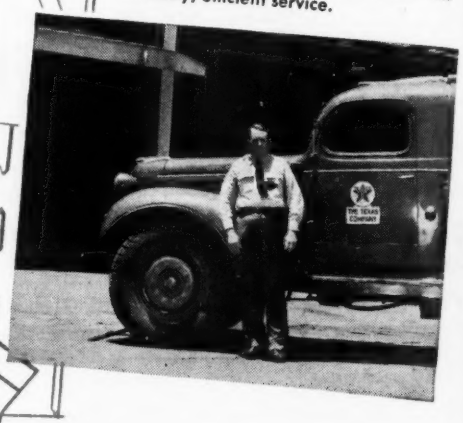




This Roller Attachment Prevents Scratched Sheets

• To eliminate scratches on aluminum sheet when it is moved across shear table, Westinghouse Mansfield plant fitted a roller along table edge. Result was not only scratch-free product, but also enabled was reduction in work force from three operators to two.





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For the past 11 years, *Texaco Aviation Gasoline* and *Texaco Aircraft Engine Oil* have been top-ranking favorites with Southwest Airmotive — just as they are with other progressive airports all over the country, and with leading airlines. In fact —

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RECONVERSION RUSTPROOFING

4 Points to Remember

1. Ordnance Specification P.S. 300-4 contains *official instructions* for the complete processing of Government-owned production equipment.
2. These instructions require that only rustproofing materials meeting Government specifications be used.
3. *Texaco rustproofing products meet Ordnance specifications for application on Government-owned equipment.*
4. For full information, see your Texaco representative or write to us.

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FOR THE AVIATION INDUSTRY

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THIS DOUBLE-DUTY SCORESBY SAVES TIME AND SPACE

Combining two automatic pilot mounts on one base, American Export Airlines uses one unit for instruction while continuing regular tests of aircraft equipment on the other.

FACED WITH THE NECESSITY for continuous training of instrument maintenance mechanics, while continuing at the same time regular airline maintenance of the automatic pilots used on both civilian and military aircraft, American Export Airlines' instrument department designed and built on a single base a two-unit Scoresby with several outstanding advantages over the single model generally used.

Mounted on a standard Sperry base, which gives a reversal of rotation every 7½ rev., this machine (Fig. 1) has these noteworthy features: Because each half of the testing mechanism is similar to the other, two entirely independent tests may be made at the same time, if a sudden demand should require it; one section of the Scoresby may be used for instruction purposes while the other is still reserved for routine tests; also, floor space and initial investment are considerably less than would be required for two separate machines to perform the same work.

Testing requirements called for supply of vacuum, also oil under pressure, both being closely regulated to conform with flight conditions. These were taken from the regular shop supply lines used for all instruments.

Servo units and the other motion-providing parts were standard units as used with automatic pilots on aircraft, but the method of connecting them was necessarily different. Referring to Fig. 2, the servo units are at the back of the machine and are connected to the follow-up pulleys by cables running over standard ball bearing pulleys outside the edge of the table. Because the spring operated follow-up pulleys exert sufficient force to keep the cables taut and since there are no control surfaces to be moved, cable connections are made only to one end of the servo piston rods, instead of to both ends as is necessary in the airplane itself.

Another simplification, as compared to the flying installation, is the use of a hand wheel instead of the remote control engaging lever for cutting out servo action to prevent motion.

The two sets of servo units are mounted on each side of the vertical back edge of the table, allowing simpler piping and cable installation than if they were placed in the normal fore and aft position.

Fig. 1. Front view of automatic-pilot-testing Scoresby, built in two identical sections to permit use of one half for instruction without affecting use of second part for operational testing. In emergency, both sides may be used for either of above purposes. Chief Mechanic Gosse, of AEA, is shown checking bank-and-climb unit of auto pilot (left) while directional gyro indicator is in right section. Entire unit reverses direction of rotation every 7½ rev. In upper portion, timer is in center, with vacuum gages on each side and oil pressure gages below. Four brass valve wheels below gages regulate vacuum to instruments being tested. Large circular objects in right section are air relays operating balanced oil valves (detail 11 in Fig. 2). Socket below air relays is for instrument lighting. (AEA photos)

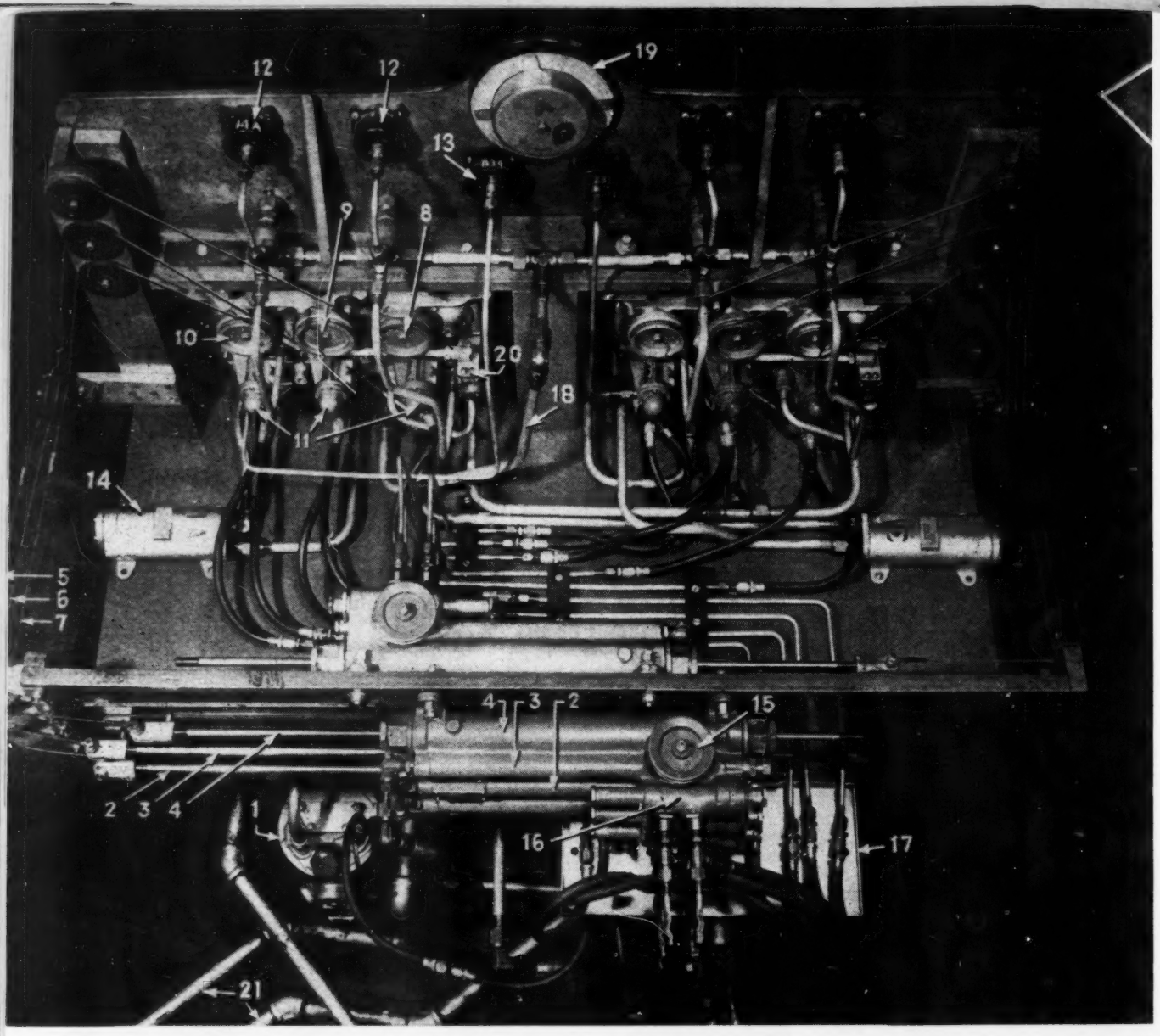


Fig. 2. Top rear view of automatic-pilot-testing Scoresby. Sump (1) is oil reservoir which receives return oil from all parts, (2) is elevator servo, (3) aileron servo, (4) rudder servo, (5) rudder follow-up cable, (6) aileron follow-up cable, (7) elevator follow-up cable, (8) rudder follow-up pulley, (9) aileron follow-up pulley, (10) elevator follow-up pulley, (11) balanced oil valves regulating oil flow to servo units, (12) vacuum gages, (13) oil pressure gages, (14) oil filter, (15) Manually operated "on-off" valve for bypassing servo when necessary, (16) overflow or relief valves, (17) drip pan draining into sump, (18) vacuum supply line, (19) timer clock, (20) incoming air to case, and (21) air and vacuum supply connections. Parts of only one section are numbered, opposite section being similar.

To permit rapid and effective connections to be made between the units to be tested and the mounts, tapered projecting tube ends are provided at the face of each mounting bracket, against which the instruments press when in place, forming a tight connection without use of threaded parts, which would be both difficult to install and would need constant replacement through wear caused by frequent instrument changes.

The timer (detail 19, Fig. 2) is the only instrument which is not taken from the original Sperry automatic pilot equipment. Its use is essential in checking reaction time of follow-up mechanisms, servo units, and air relays, since these must operate within fairly close time limits to avoid too rapid control surface movements or over compensation. The instrument is a standard Kodak photographic timer with front control knobs.

Seen in Fig. 1 is the right hand mounting unit being used for testing a directional compass indicator. In this case, the servo units and the other parts which would be used on the airplane for operating control surfaces are not in action. Testing of artificial horizons is performed in a similar manner.

Regulation of the vacuum used for operating the gyros is obtained by turning the knobs (shown in Fig. 1) on the lower front of each mounting unit. The knobs are marked "rudder", "aileron", and "elevator", reading from the left. Turning these knobs clockwise reduces the gyro speed (normally 12,000 rpm.), while the opposite rotation causes an increase in revolutions.

Current from the shop supply line is led to sockets beside the air relays, for lighting the instruments.

Oil for servo operation is placed in the sump (detail 1, Fig. 2) and passes through the filter (14) each time it is circulated through the system. Since the capacity of the six servo units is quite large compared to that of the sump, the oil is circulated and filtered sufficiently frequently to prevent there being any likelihood of foreign matter reaching the instruments. Plumbing is shown in Fig. 3.

Credit for the design and successful operation of this machine is due to G. A. Warde, J. E. Bowley, E. H. Raignel, and F. A. Massie, all of AEA's instrument department, who designed and constructed this unit while carrying on the routine instrument maintenance incident to airline and AAF combined operations.

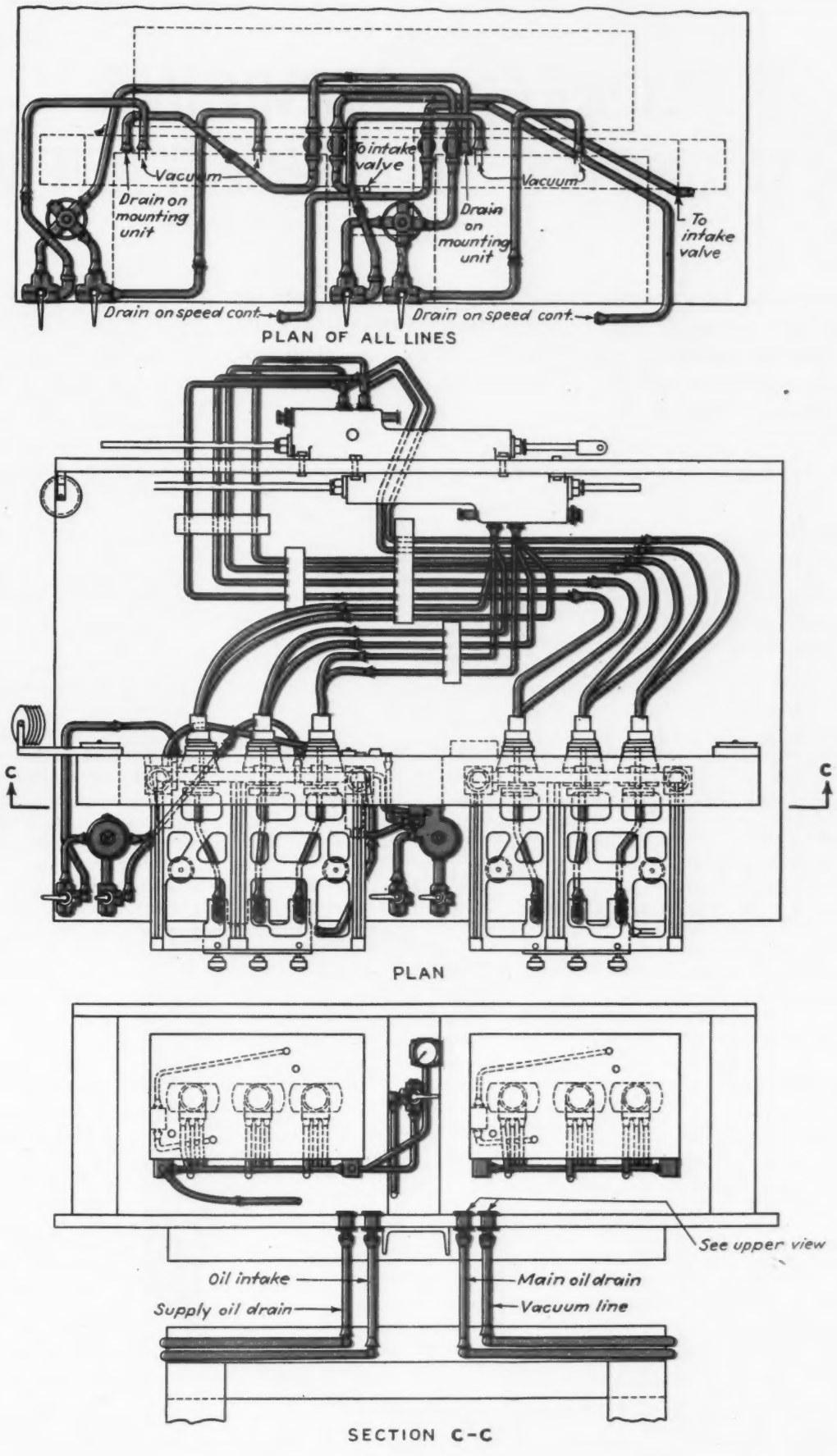


Fig. 3. Piping arrangement of AEA's automatic-pilot-testing Scoresby.

CORRECT SERVICING DETERMINES DE-ICER EFFICIENCY

PART II

Precisely detailed here are the step-by-step working methods for making all types of de-icer repairs which involve vulcanizing—with each job and "fix" tabulated, the curing times carefully calculated, and all do's and don'ts noted. . . . Concluding installment of this two-part "how-to" feature.

VULCANIZED REPAIRS on de-icers call for extreme care in preparation and curing because of the constant bending while in use, accompanied by great variations in temperature and atmospheric conditions.

Vulcanizers supplied in B. F. Goodrich Kit No. 3041 are adjusted at the factory to heat to 285 deg. F, with voltage specified on the name plate. All curing times are calculated for this temperature, and if line voltage is lower curing times must be longer than specified.

Since the curing time varies with the type and position of repair being cured, the time has been given, in the instructions, for each type of repair.

Because over-curing destroys the flexibility of the de-icer and undercuring prevents the proper bond from taking place, curing time should be carefully watched.

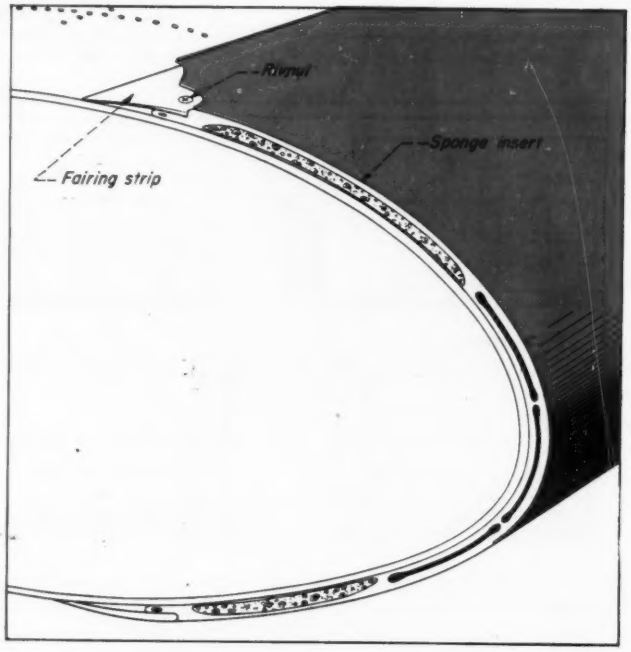
Curing Procedure

1. Preheat vulcanizer.
2. Place sponge pad over bottom of unheated platen with a piece of clean, unwrinkled holland over sponge pad, then place de-icer in position over holland centrally with area to be cured, after which place another piece of smooth, clean holland over spot. (If holland is not available, spread a thin coat of soap and water over surfaces of tin and sponge pad and let dry thoroughly. This will prevent sticking.)
3. Set holland and clamp heating element in place under metal curing plate at least 1 in. larger than heating platen. Heater should be tightened firmly by hand.
4. Cure for time specified.
5. Test each repair thoroughly after curing. If on a tube, inflate to 10 psi. If in stretch area, flex and stretch by hand several times, then carefully examine for soundness.

Conductive Surface Repairs

The *conductive surface must be restored* on face if there are scuffs or gum repairs.

1. Wash surface, paint with conductive cement, and allow to dry thoroughly, then add another coat and let dry.



Some de-icers are equipped with sponge rubber inserts to provide a smooth contour. Repairing of this type calls for special technique. (Courtesy B. F. Goodrich)

2. Dip finger in conductive cement solvent (isopropyl acetate) and rub down with light circular movement. (Do not allow finger to become dry.) Then wipe surface lightly with cloth moistened in conductive cement solvent.
3. Inspect for high or low places. High places require additional rubbing down. For low spots, repeat steps 1 and 2.
4. Allow to dry thoroughly and apply soapstone.

For shallow scuffs in conductive surface:

1. Wash surface, then smooth scuff with felt disk in electric buffer.
2. Wash again to remove loose particles.
3. Restore conductive surface by method previously described.

Deep scuffs through conductive surface are treated as follows:

1. Wash area to be repaired.
2. Rout both conductive surface that has been scuffed and as much of the cured rubber as is necessary to remove pits, buff $\frac{1}{8}$ in. around outer edge of routed area, then cement.
3. Pack routed area with uncured gum, flush with conductive surface.
4. Cement $\frac{1}{8}$ in. buffed area with one light coat, then cure 10 min. and restore conductive surface.

Flap Repairs

Torn flaps call for following operations:

1. Wash fabric side of flap, buff $\frac{3}{4}$ in. around tear, and cement buffed area.
2. Cut a patch of flap repair fabric which will extend $\frac{1}{2}$ in. beyond all sides of tear, cement patch with one coat, and allow to dry.
3. On cemented patch, place a strip of .020 gum. (When fabric patch is in position, gum should extend $\frac{1}{4}$ in. on all sides of tear.)
4. Place gummed patch on fabric side of flap with gum next to tear. Stitch firmly. (Edges of tear should have at least $\frac{1}{16}$ in. clearance so vulcanizer pressure can force

the gum between edges of tear forming a flush surface.
5. Buff and cement ⅛ in. area along edges of tear on conductive surface side.
6. Cure 10 min. and restore conductive surface.

Flaps torn loose from bead:
1. Wash area and rout to a depth of .010 the face ply from which the flap has been torn, then wash and cement routed portion.
2. On cemented area, lay a strip of .010 gum 3/16 in. wide. (Edge of gum strip must fit tightly against inside edge of routed area.)
3. Buff and cement the area of flap where torn loose and let dry.
4. Lay flap in place allowing 1/16 in. clearance between edge of flap and inner edge of routed area.
5. Buff ⅛ in. area on both edges of repair and apply one light coat of cement.
6. Cure 12 min. and restore conductive surface.

When necessary to lay in a new piece of flap, proceed as in "Flaps torn loose from bead", then as in "Torn flaps", using cured flap material.

Stretch Area Repairs In De-Icers Without Sponge Filler

Small holes or tears not over ¼ in.:
1. On face side, rout around hole or tear so that bowl shaped depression is formed approximately .020 deep, then buff ⅛ in. beyond edge of bowl.
2. Wash, cement, and pack depression with gum until flush with conductive surface. Stitch firmly.
3. Cement the ⅛ in. buffed area with one light coat.
4. Treat back of torn portion as described in 1, 2, and 3.
5. Cure 10 min. on face, reverse and cure 5 min., then restore conductive surface.

Holes or tears, over ¼ in.:
1. On back side of de-icer, rout to depth of .015. Allow a ¼ in. to ½ in. clearance on each side of tear, then wash and cement routed area.
2. Cut a piece of coated reinforcing fabric to size of routed area. Be sure fabric will stretch at right angles to longitudinal centerline of de-icer.
3. Wash and cement on side of this fabric, then place in position over tear and stitch.
4. Cut a ⅛ in. strip of gum and place on edge of fabric to round it off.
5. On the face of de-icer, rout a shallow bowl or V-shaped trough around the hole or tear.
6. Buff ⅛ in. beyond routed area, then wash and cement routed and buffed portion.
7. Pack bowl or trough with gum, flush with surface.
8. Cure 10 min. on face side, reverse and cure 10 min., then restore conductive surface.

Electric vulcanizer showing bracket attached to wing. Top and bottom adjusting screws permit bracket to be moved to best position for applying even pressure. Note that all adjustments are for hand (not wrench) tightening. (Curtiss-Wright photo)

Stretch Area Repairs In De-Icers With Sponge Filler

Small holes or tears not over ¼ in.:
1. On back side of de-icer, buff around hole or tear, then wash and cement buffed area. Be sure sponge filler is cemented.
2. Pack hole or tear with gum and cement one light coat ⅛ in. beyond edge of repair.
3. Rout shallow depression on face around hole or tear forming a bowl or V shaped trough. Buff ⅛ in. beyond routed area, wash and cement.
4. Pack bowl or trough with gum flush with surface.
5. Cure each side 10 min. and restore conductive surface.

Large holes or tears over ¼ in.:
1. On back side of de-icer, if sponge is torn and no parts missing, separate sponge from bottom ply.
2. Lay back sponge to expose bottom ply ¾ in. around hole or tear.
3. Buff and wash bottom ply. (Do not moisten sponge filler.) Then cement bottom ply.
4. Cut a strip of coated reinforcing fabric to extend ½ in. beyond sides of hole. (Be sure stretch in fabric is at right angles to beads.) Then wash, and cement fabric strip with one coat only.
5. Position prepared fabric strip and stitch firmly.
6. Cement surface of fabric strip and exposed sponge filler. Let dry, return sponge filler to position, and stitch.
7. Cement all cut edges in top ply and sponge filler.
8. Fill between edges with .010 gum and stitch thoroughly. (If back of de-icer is ribbed over sponge filler, ribs in the new gum can be formed by curing with a piece of cured ribbed material with ribs next to new gum. Coat cured ribbed ply with soap and let dry before using.)
9. On face, rout edges of hole to form a shallow bowl or V. Buff ⅛ in. beyond routed area and cement surface.
10. Fill bowl with gum flush to surface.
11. Cure 12 min. on face, reverse and cure 10 min., then restore conductive surface.

Tube Area Repairs

Small holes or tears through one side less than ¼ in.:
1. If on the face side of shoe, rout the rubber ¼ in. wide around hole almost down to the tube fabric. (Do not injure the fabric.) If on back, merely roughen area lightly.
2. Wash and cement.

3. Completely cover tear with .010 gum.
4. Lay on a piece of lightweight reinforcing fabric, exact size of routed area. Fabric must be cut and laid in on the bias with respect to the length of the tube.
5. Fill in with gum flush with outer surface on face. On back, cover with .010 gum.
6. Cure 12 min. and restore conductive surface.

Large holes or tears through one side over ¼ in.:

(Note: Inside of tube must be reinforced as well as outer side. Inside reinforcement is applied first.)

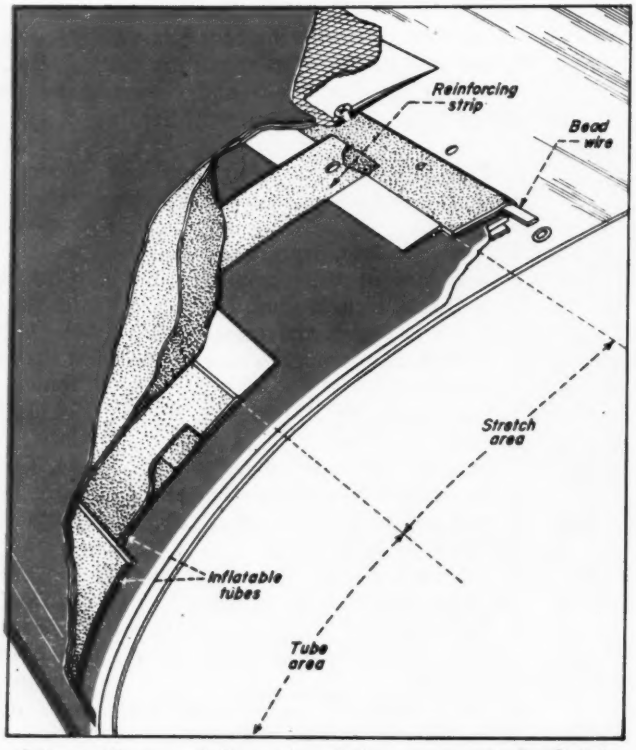
1. Through tear in tube, deposit a small amount of soapstone on tube wall directly opposite tear.
2. Holding tube open, buff inside area surrounding tear. If tear is through tube seam, first remove tape on inside for ½ in. on either side of injury.
3. Wash and cement. Do not allow cemented area to touch opposite tube wall. A small piece of holland may be inserted to prevent contact.
4. Cut a piece of lightweight reinforcing fabric, on the bias with reference to length of tube, and rub one side with soapstone, then wash and cement opposite side.
5. When cement is dry, remove holland from tube and insert bias-cut patch so that the cemented side of patch contacts cemented area in tube.
6. Carefully work patch in place and close up tear over patch. Roll thoroughly with roller.
7. Repair outer surface by applying a patch by method outlined for small holes.
8. Cure for 15 min. and restore conductive surface.

Holes or tears through two sides ¼ in. maximum:

Repair one side at a time same as for damage to one side.

Hole from one tube into another:

1. Mark out an area around damage on both face and back, allowing ½ in. clearance on all sides.
2. Rout rubber in area and buff surface ⅛ in. beyond. (Be careful not to injure fabric.)
3. Remove in-between tube fillet across routed area, creating a 1/16 in. slot between tubes. (Do not injure tube edges.)
4. Cut on a bias two pieces of lightweight reinforcing fabric, so that when inserted through the slot, they may be wrapped around tube edges and cover routed area on both face and back. Wash routed areas and cement.
5. Completely cover tear with .010 gum on face and back.
6. Wash fitted fabric patches and cement.
7. Dip first patch in washing solvent and quickly slip it into position in 1/16 in. slot. Allow solvent to evaporate before stitching down.
8. Stitch patch in place on face and back of de-icer. Patch must fit tightly against tube edge.
9. Prepare second patch and proceed as in 7 and 8.
10. To complete the repair on back:
    a. Cement.
    b. Replace in-between tube fillet strip by forcing thin strips of gum between tube edges until flush with surface of tubes.
    c. Replace ½ in. seaming tape which covers in-between tube fillet strip and tube edges with ½ in. bias-cut strip of lightweight reinforcing fabric.
    d. Cover entire repaired area with .010 gum.
    e. Stitch thoroughly and cement ⅛ in. buffed area beyond gum edge to care for any overflow.
11. Turn de-icer over and complete repair on face side. Proceed as in 10, except that no ½ in. seaming tape is to be used.
12. Place clean holland cloth over repairs on both face and back.
13. Vulcanize 15 min. on face, then reverse, vulcanize 10 min., and restore conductive surface.



Cutaway diagram of the various de-icer components handled in making vulcanized repairs. (Courtesy B. F. Goodrich)

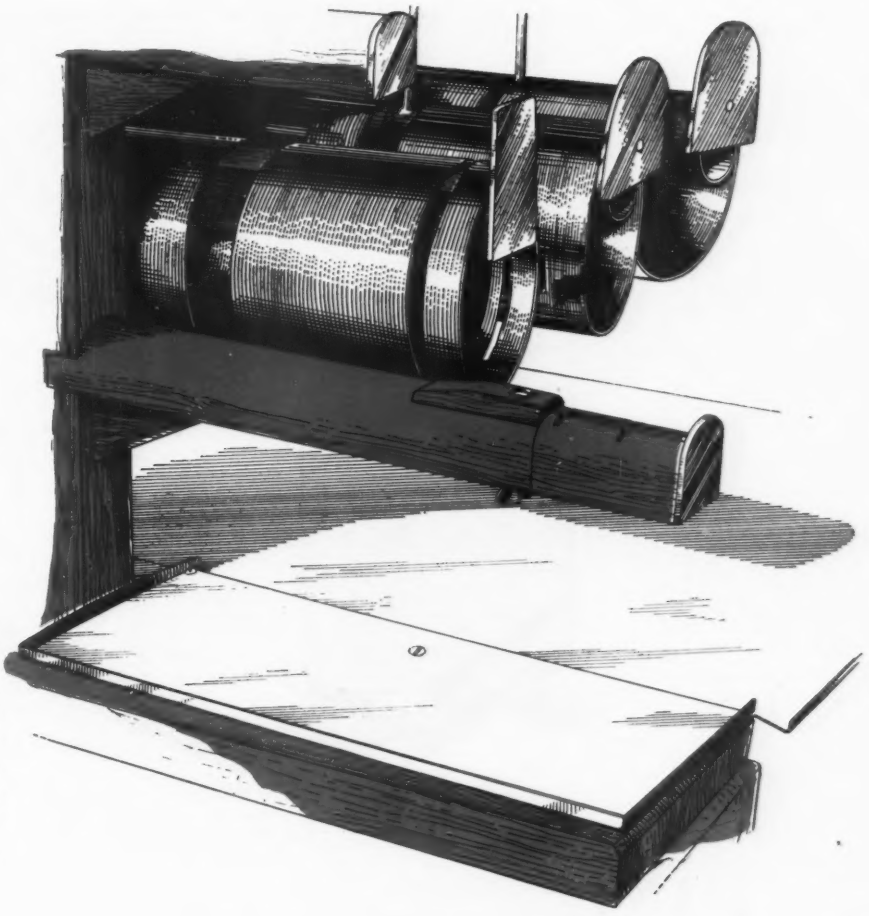
When tear is through stretch area into tube:

1. Wash and rout an area ½ in. wide on all sides of injury on both face and back down to fabric surface.
2. Cut through stretch area along edge of tube for width of routed area. (Do not injure tube edge.) Then wash and cement both face and back.
3. Completely cover tear in tube on face and back with .010 gum.
4. Cut on a bias, a piece of lightweight reinforcing fabric so that it may be wrapped around the tube edge, and cover routed area on face and back of tube.
5. After fitting fabric patch, remove it, wash, cement, let dry, and replace. Then stitch down thoroughly to exclude air.
6. Cover patch with .010 gum and stitch thoroughly.
7. Working from back of de-icer, separate the sponge filler and lay it back so bottom ply is exposed ¾ in. on each side and at end of tear.
8. Buff, wash, and cement bottom ply. (Do not moisten sponge filler.)
9. Cut a strip of coated reinforcing fabric to extend 1/16 in. on tube edge and ½ in. beyond edges of tear, making sure that stretch in fabric is at right angles to longitudinal centerline of de-icer.
10. Wash fabric strip and cement it, one coat. Let dry, then place prepared strip in place and stitch thoroughly.
11. Cement one light coat on surface of fabric and exposed sponge filler. Let dry and replace sponge filler.
12. Cement edges of cut in top ply and sponge filler and let dry. Fill between edges with .010 gum and stitch thoroughly.
13. If back ply is ribbed, ribs in new gum can be formed by using cured ribbed gum with ribs next to new gum in vulcanizer. Coat cured ribbed ply with soap to prevent sticking.
14. On face side rout edges of tear so a small V-shaped trough is made approximately ¼ in. wide.
15. With carborundum stick, buff ⅛ in. beyond edges of trough, then cement trough and buffed area.
16. Fill trough flush to surface with gum.
17. Cure 12 min. on face, reverse and cure for 10 min., then restore conductive surface.

Pitot hole and antenna lug hole repairs:

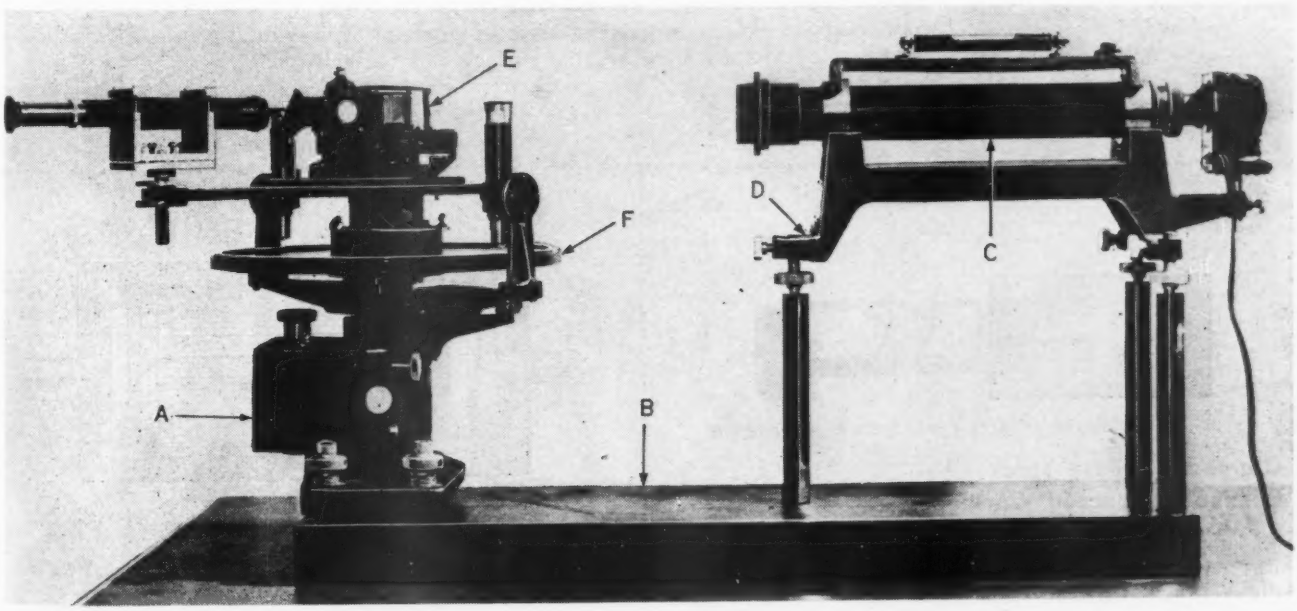
1. Rout reinforcing fabric

(*Turn to page* 250)



Piston Ring Sets Counted Automatically

• By simple expedient of attaching small block to wooden arm, old time-taking way of counting piston rings into sets for various types of engines has been dispensed with. Upper arms serve as storage racks while lower one, with its adjustable block, may be set to accommodate whatever number of rings are required for the engine being equipped.

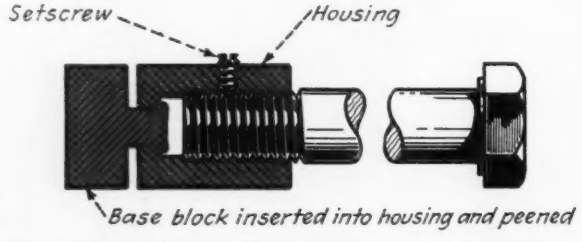


Sextant Collimating Fixture Simplifies Accurate Checking

• Backlash and scale readings of sextants are now checked in less than 1 min. by fixture invented by G. E. Dennewitz of FATSC. Using AC equipment and adapting driftmeter vertical collimating stand, method is accurate within 15 sec. of a degree. Cradle (A) is mounted on base (B), while collimater (C) and stand (D) are mounted in optical line of sight. Backlash and scale readings are taken from sextant (E), while setting is by means of wheel (F).

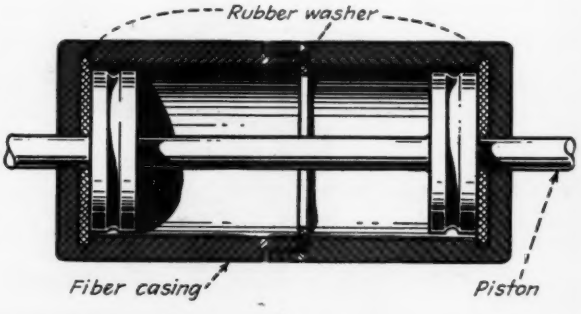
Handy Skid Box Saves Many Steps

• To provide both weatherproof and easily moved storage for tools used in line service on the apron, UAL devised this skid-mounted combination tool box and work bench. In addition to keeping all tools in one place near the work in hand, box affords a steady working surface, due to skids being used instead of wheels. Part hinged to edge of cover lets down to enclose front of shelves.



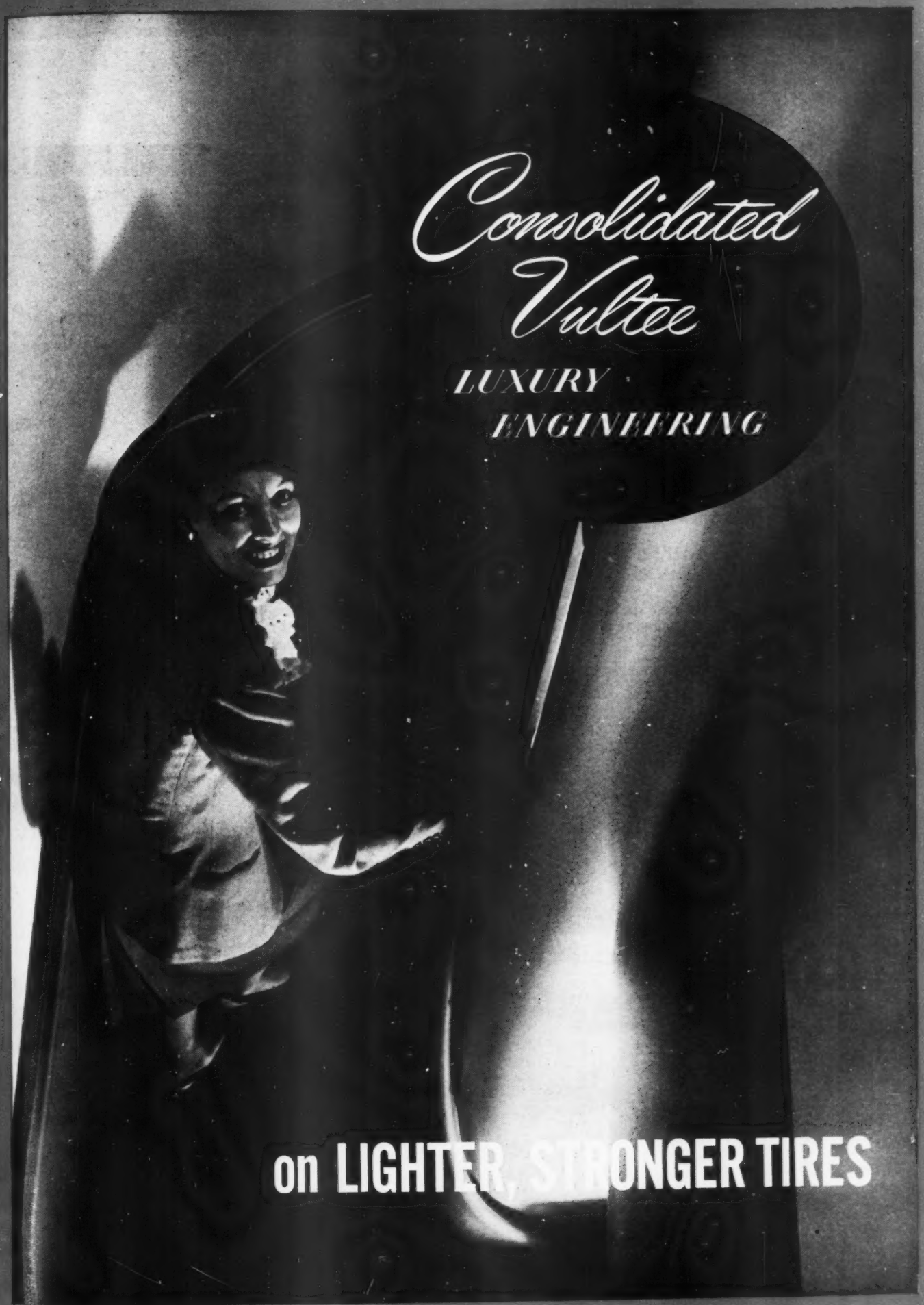
Clamp Bolt Base Block Eliminates Scarred Work

• Clamp bolts, used in securing wing assembly parts at Fleetwings Div. of Kaiser Cargo, formerly disfigured the polished metal surfaces when being tightened. If shims were used to prevent this scarring, they frequently slipped and necessitated readjustment, with an average loss of 15 min. per wing. Devised by Elmer Cross, this safety block was attached to the bolts, transmitting pressure directly to metal and saving not only readjustment time but also costly burnishing for removing blemishes.



These Fiber Shields Save 5 Hr. Per Piston

• Through use of shields and washers to replace the old tedious masking operation when chrome plating hydraulic valve pistons, Fleetwings Div. of Kaiser Cargo has saved more than 5 hr. per piece. Shields, developed by E. Davis of hydraulics dept., are made from fiber and are sealed by rubber washers to protect portions not to be plated.



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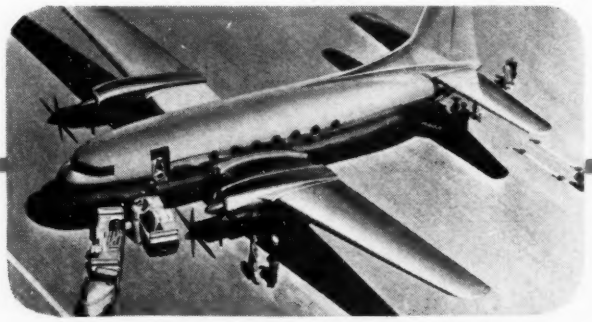
ENGINEERED BY CONSOLIDATED VULTEE

Stinson Voyager 150 A small plane with large plane characteristics, its sturdy 150 horsepower engine develops 133 m.p.h. maximum speed, 125 m.p.h. cruising speed. It accommodates four passengers, baggage and sufficient fuel for 500-mile, non-stop flights.



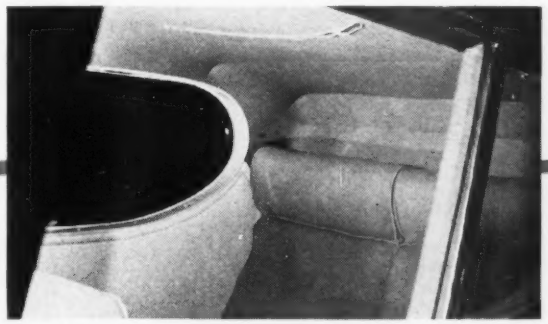
Consolidated Vultee 110 The "airplane the airlines asked for" is engineered for the ultimate in passenger comfort and operating efficiency. This 30-passenger postwar transport has a cruising speed of 275 miles an hour, carries an 8,000 pound pay load.

Consolidated Vultee 37 When you enter this great queen of the skies, you will see the graceful circular stairway shown on the previous page. From London to New York in about nine hours, it will carry 204 passengers and 15,300 pounds of baggage with its six engines producing power equivalent to 353 average automobiles. As in all Consolidated Vultee planes large and small, passenger comfort and convenience come first.

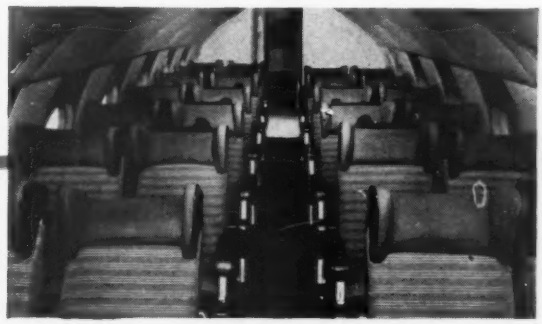
BUILT IN BY CONSOLIDATED VULTEE

✻ *the glorious feeling of luxurious security*

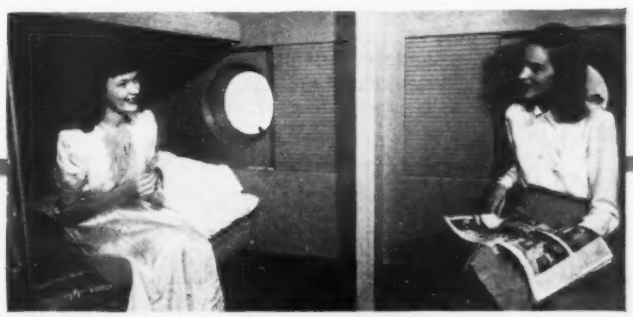
INTERIORS CREATED BY HENRY DREYFUSS



STINSON VOYAGER 150 Every detail of this interior spells comfort. Luxurious fabrics, soft, warm colors, deep-cushioned upholstery give living room comfort to this private plane.



CONSOLIDATED VULTEE 110 Spacious comfort and that glorious feeling of luxurious security are built into "the airplane the airlines asked for". Spun glass insulation gives quiet relaxation.

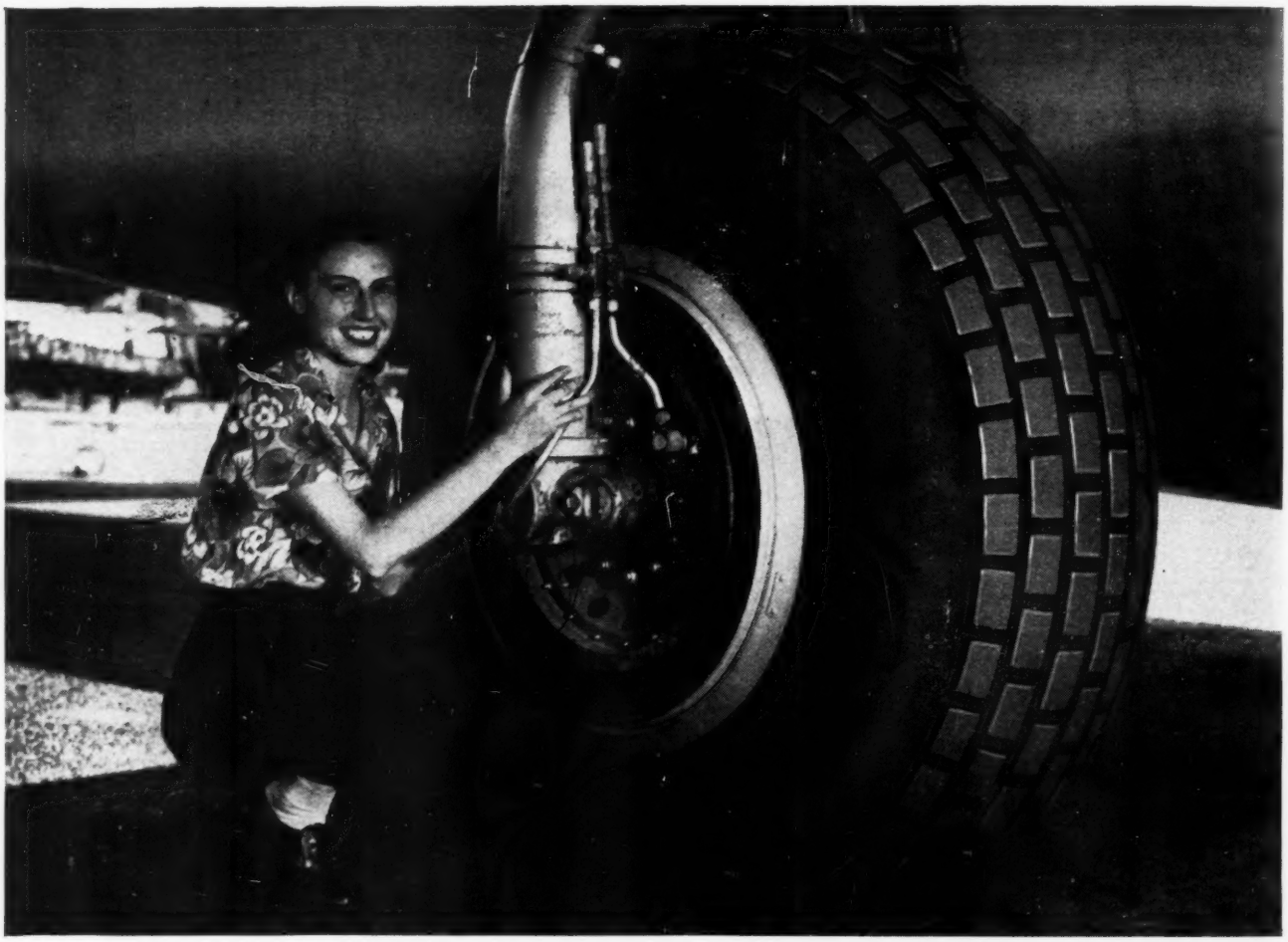


CONSOLIDATED VULTEE 37 You can't believe it. You're not in the Ritz, you're in an airplane... the latest interior creation by Henry Dreyfuss. Only one word will describe it... and that is the name created for it... the ultimate in "luxurity"!

COMFORT... absolute and effortless... you can even turn off the sun!

CONVENIENCE... soft, ample lighting, flawless mirrors...a challenge to beauty.

LUXURY... every corner breathes thoughtful care...complete luxurity.



On Consolidated Liberator bombers, U.S. Royal Airplane tires carried bomb loads mounting into the millions of pounds, cushioned their cargo over runways of every type—landed their ships and crews safely when "mission completed."

...AND IT'S *Luxurity First* WITH U.S. ROYAL AIRPLANE TIRES

Whether for the smallest private airplane, for the modern, postwar transports that link our cities at home or the queens of the sky that fly the oceans of the world, U.S. Royal Airplane tires are built to give to every landing and every take-off that glorious feeling of luxurious security that is expressed in the word "luxurity."

With bodies of rayon and nylon, pioneered for the Aviation Industry by United States Rubber Company, these lighter, stronger, safer U.S. Royals, like the Stinson Voyager, the Convair 110 and the great new Convair 37 are designed to lead the way to a new concept of air transport in a peacetime world.

Listen to "Science Looks Forward"—new series of talks by the great scientists of America—on the Philharmonic-Symphony Program. CBS network, Sunday afternoon, 3:00 to 4:30 E.S.T.

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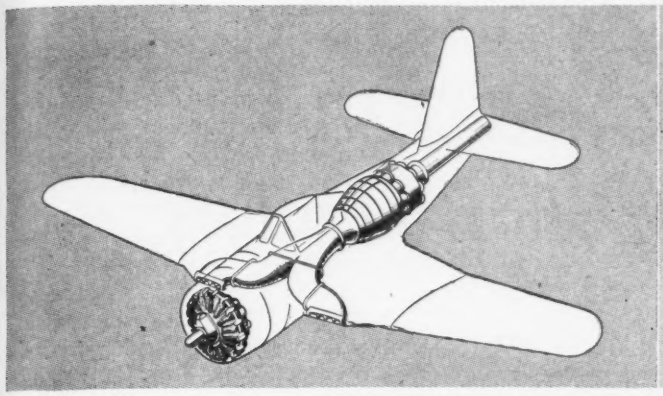
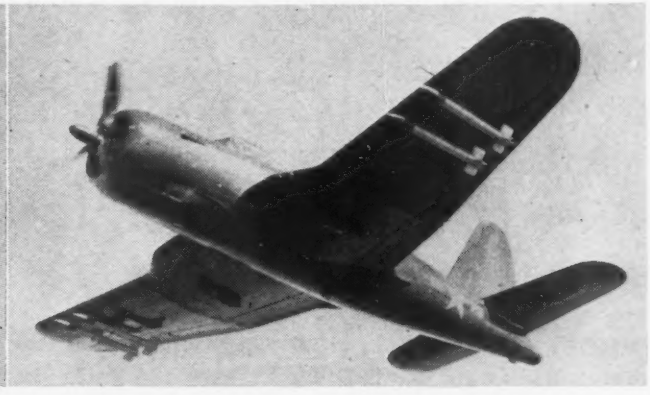


Phantom view showing installation of 1,350-hp. R-1820 Wright Cyclone reciprocating engine in nose and General Electric I-16 jet engine in fuselage aft of cockpit. High speed on reciprocating engine alone is 320 mph., on jet alone is about 300, and with both is well above 400 mph.



Ryan FR-1 Fireball, first plane equipped with both reciprocating and jet engines, demonstrates quick takeoff and high rate of climb. In addition to rockets shown, craft can carry two 1,000-lb. bombs or droppable gas tanks on fittings seen under turbine air inlet ducts. Openings for four 50-cal. machine guns are alongside ducts (U. S. Navy photos)

Jet and Conventional Engines Combined in Ryan FR-1 Fireball

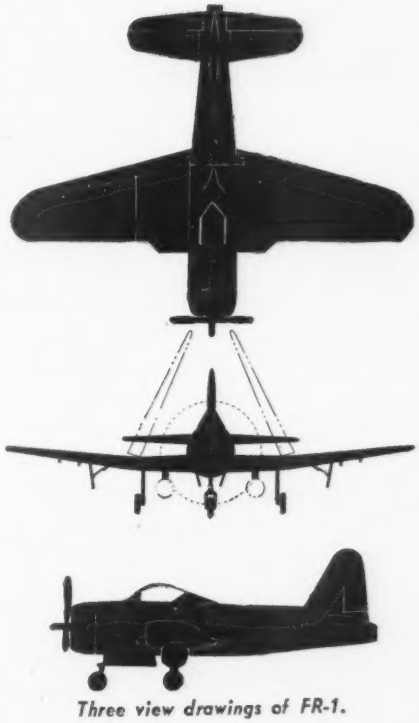
First craft of type has both high climb rate and maneuverability at all altitudes. And cruising on reciprocal engine, plane has maximum range of 1,500 mi.

FIRST AIRPLANE in the world to combine conventional and jet propulsion power plants, the Ryan FR-1 Fireball also holds the distinction of being the first U. S. Navy JP job, and the first carrier-borne craft with tricycle landing gear.

Perhaps as important is the fact that it may also be the first of many craft to employ both types of power plants, for the FR-2 is already under development and knowledge gained in shaping up the original production model has, according to the Navy, "been utilized in developing other new planes."

Conventional power plant is a 1,350-hp. R-1820 Wright Cyclone turning a three-blade Curtiss Electric propeller; while the jet unit is a General Electric I-16 modified to use the same fuel as the reciprocating engine, thus eliminating the need for dual fuel systems.

The jet unit is housed inside the fuselage just aft of the wing trailing edge. The fuselage can be quickly broken at this point by removal of four bolts, breaking of quick disconnect-multiple electric circuits, quick-disconnect fuel lines, and similarly designed control cables. The jet engine top attachment is a monorail on which the engine pickup rides, thus helping to make a complete jet engine change possible in less than an hour.



Three view drawings of FR-1.

Pilot's cockpit is well forward to give very good visibility over the leading edge of the wing, and the bubble canopy has an airfoil design that pulls it up and away from the pilot when jettisoned.

Wing center section is built as one unit, extending through the fuselage to landing gear hinge points. Turbine air inlet ducts are set in the leading edge adjacent to the fuselage, and two 50-cal. machine guns are set just outboard of the ducts on each side. They may be serviced after folding of the

(*Turn to page 246*)

Specifications and Data

Span	40 ft.
Length	32 ft.
Height	13 ft. 6 in.
Height, wings folded	16 ft. 9 in.
Gross wt.	9,800 lb.
Wt. empty	7,475 lb.
Wing area	725 sq. ft.
Wing loading	35.6 lb.
High speed, Wright engine only	320 mph.
High speed, GE jet engine only	approx. 300 mph.
High speed, both engines	over 400 mph.
Maximum range	1,500 mi.
Armament	Four 50-cal. mg., two 1,000-lb. bombs, minimum of four HVAR rockets

Martin 202 and 228 Planned as New Short-Haulers

Company reveals that mass production of 30-seat Model 202 is projected. Model 228 is to be similar, but designed for lighter runs. Ease of maintenance is stressed in both, with many parts to be readily interchangeable.

Artist's sketch of new Martin 202 airliner for 30-passengers shows how craft will look in operation. P&W Double Wasp engines are to be fitted with four-blade reversible pitch propellers, and craft is to have tricycle landing gear. Radar devices will also be used. It is stated that a second company design, Model 228, will be similar in appearance, but will be powered by Wright Cyclones and seat 26. Many parts of both craft are designed to be interchangeable. Martin believes that three-fourths of all planes on commercial routes will be twin-engined.

GLENN L. MARTIN Co. now intends to enter the feederline transport field with two new designs—the 30-passenger Model 202, and a 26-seat lighter craft designated the 228.

After preparing 21 separate designs, a mockup of the 202 has been built, and the company states that mass production is to get underway as soon as the prototype passes CAA tests. The craft has been designed to ATA A-1 specifications.

Power plants are to be two 2,100-hp. P&W R-2800-2SC15G Double Wasps, fitted with a new jet-exhaust system designed to increase the craft's cruising speed by 20 mph. Normal gross weight is planned at 34,300 lb. and weight empty at 22,023 lb. Top speed at 10,000 ft. is estimated at 306 mph., and cruising speed at the same altitude using 70% power at 270 mph. Stalling speed is given as 80 mph., and rate of climb is put at 1,600 fpm. Maximum operational ceiling is calculated to be 30,000 ft., and the craft is to maintain a one-engine ceiling of 16,000 ft.

Propellers may be either four-blade Hamilton Standards or Aeroprops of the reversible pitch type. Retractable tricycle landing gear is to be fitted with dual main wheels, and the nose wheel will be steerable. Synthetic rubber Martin Mareng fuel cells are to be used.

Passenger seats will be arranged two abreast on each side of the aisle, and the cabin will have soundproofing, indirect lighting, and heating and ventilating systems. Luggage and cargo space will amount to 525 cu. ft. On entering the plane, travelers will be able to deposit lightweight luggage on shelves opposite the door and pick them up on leaving without having to wait at the terminals for baggage deliveries. Another arrangement would have provisions for under-seat stowage as well as overhead racks.

Very large passenger and cargo doors will be located on opposite sides of the fuselage of the 202 in order to permit simultaneous loading of passengers and freight. In addition there will be room under the cabin floor for radio, hydraulic, and other accessory systems, with access via service doors. The latter are to be designed on the same principle as bomb-bay doors.

Wingspan is given as 92 ft. 9 in., length as 71 ft. 11 in., and wing area as 860 sq. ft. Martin GLM-W 16 low drag laminar airfoil sections are planned. It is stated that radar and other war-born devices are to be utilized.

Model 228

Especially designed for short-haul runs on low-density routes, Model 228 is planned as a low-wing all-metal cantilever monoplane of semi-monocoque construction, with retractable tricycle landing gear.

Designed as a "little brother" to the Model 202, the 228 is to have wings, landing gear, tail surfaces, and most of the fuselage identical and interchangeable with the former craft. To seat 26, the 202 is designed for a maximum weight of 28,500 lb. The fuselage will be 68 ft. 8 in. long, height is to be 24 ft. 10½ in. and maximum fuselage cross-section, 9 ft. 8 in.

Two 1,425-hp. Wright Cyclone R-1820s are to give the craft an estimated 240-plus-mph. cruising speed, and landing speed is given as about 70 mph. It is stated that the 228 will have a minimum turning radius of only 60 ft. To be featured in the new branchliner will be a large cargo compartment, ample storage space for luggage in the entrance-way, and buffet facilities. It is stated that special attention has been given in this design to ease of maintenance, and wherever practical, left-hand and right-hand assemblies are to be interchangeable.

AA Choosing Feedliner With Aid of Employee Poll

Faced with the problem of selecting a new short-haul craft from the five designs briefed here, airline decided to weigh the varying views and perspectives of the thousands of employees in its many different departments. And seen clarified by this broad survey are the pertinent "what we need" factors.

OPINIONS of its many, different-department employees is now being sought by American Airlines as an aid in the selection of a new type of utility airliner. This interesting experiment, in the form of a special poll, involves consideration by the personnel of the design specifications submitted to the airline by five leading U. S. manufacturers, following the recent request to aircraft makers for bids.

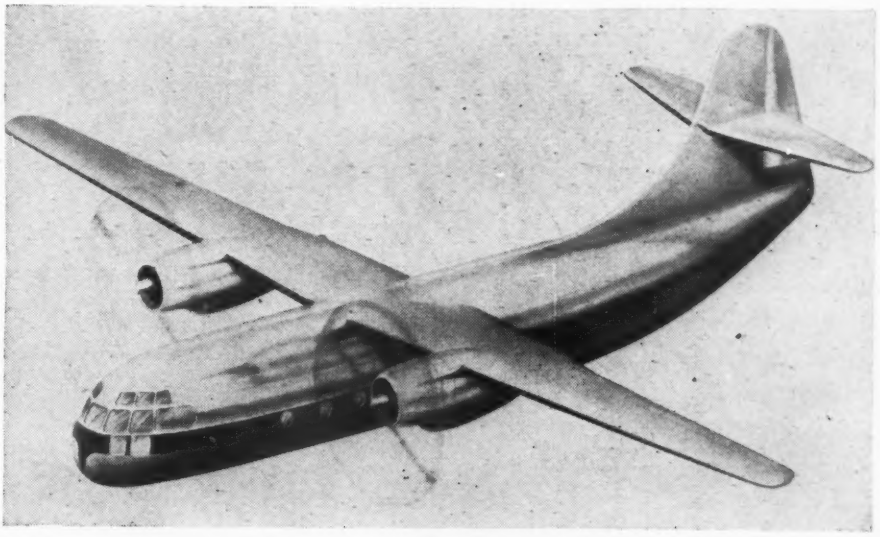
Specifically, the airline concluded, that evaluation by all of its departments would give best judgment in anticipating the varied factors and problems which might come to light with the operation of an entirely new design. Therefore the company made the move to collect opinions and ideas from nearly all of its staff of 10,000 employees regarding recommended features pertinent to flight operation, maintenance, cargo handling, and the like.

To facilitate the survey each employee has been issued a comprehensive pamphlet containing descriptions, specifications, and performance data, together with sketches of each type craft on the ground and in the air. Special features of each plane are indicated in text and drawings.

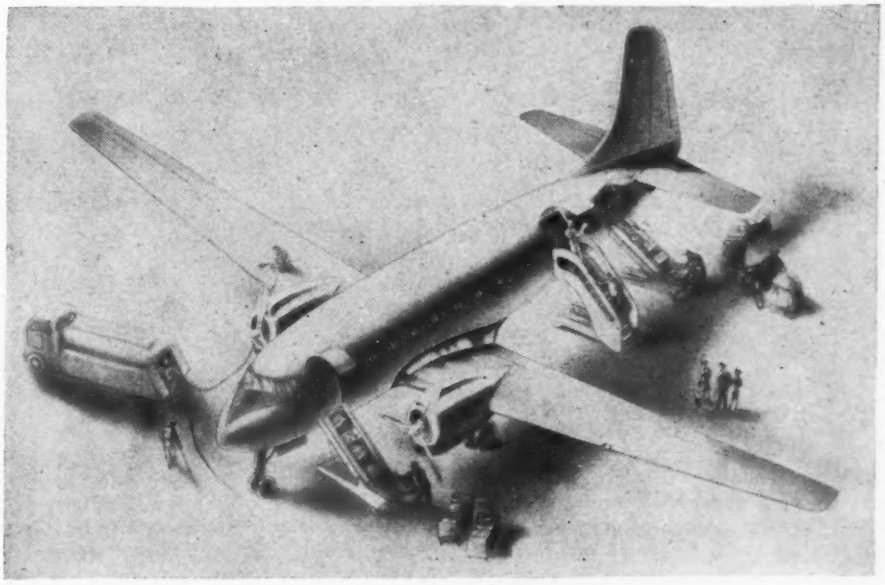
Basically, all the types are twin-engine monoplanes with tricycle landing gear and single rudder. They are the Boeing 431-16; Convair Model 110 (AVIATION, Sept. 1945, p. 171); Curtiss-Wright CW-28; Douglas DC-8 (AVIATION, Oct. 1945, p. 108); and the Martin 202 (see p. 172).

Boeing's 431-16, planned as a 30 seater, features a high wing arrangement. The wing is to go directly through the roof structure of the passenger cabin (see photo), at which point 6 ft. of headroom would be provided. Passenger facilities are to include a restroom in the rear, a galley next to the main entrance, and a wardrobe. Main wheels of the tricycle landing gear are designed to retract into the fuselage sides, and the nose gear is to be fitted with dual wheels. Elevators

(*Turn to page 247*)



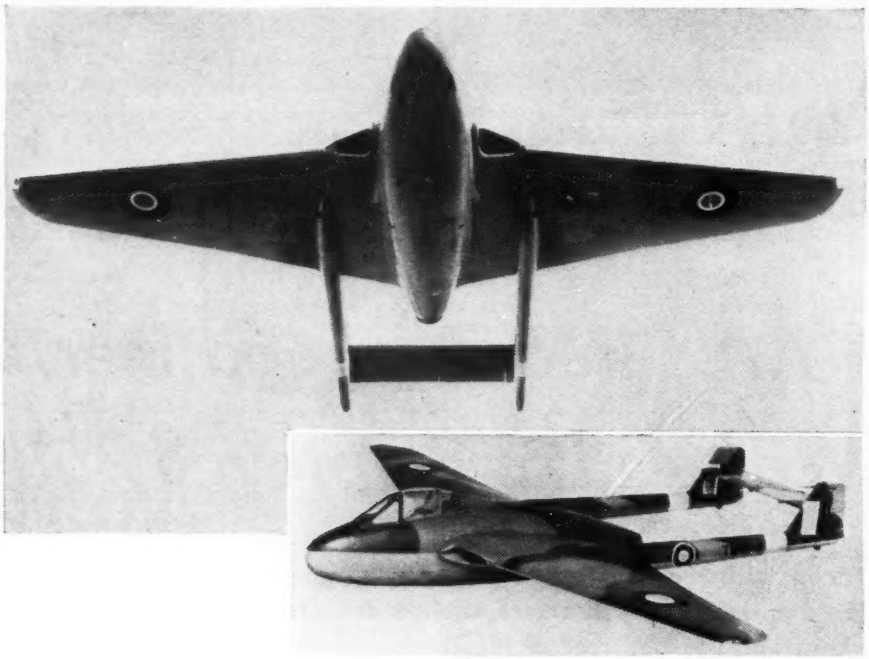
Boeing replied to AA's request for utility-transport bids with new model 431-16, a P&W Double Wasp-powered 30-passenger craft especially designed for local service operations. Main wheels of tricycle landing gear would retract into fuselage sides. At 36,000-lb. gross weight, craft would have a 252-mph. cruising speed at 10,000 ft. Special feature would be simplified baggage handling. Boeing estimates transport's operating cost at 10-12c per ton-mile.



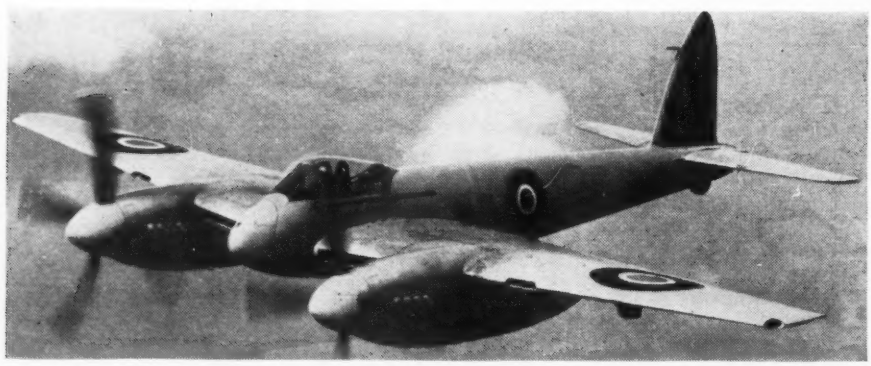
Here is 32-passenger Curtiss-Wright CW-28 feederliner design submitted to AA. This craft would be powered by 2,500-hp. Wright Cyclones, giving it an estimated 288 mph. cruising speed. It is stated that special attention has been given to stewardess facilities. Sketch depicts passenger and cargo loading methods. Span is given as 100 ft., length 73 ft., and wing area 875 sq. ft. Design bears some resemblance to company's famed Commando.

DH Vampire and Hornet Which Were Set to Jab Japs

Revealed are two new one-place fighters that were being delivered to RAF for use in Pacific when war ended. Heavily-armed high-speed craft were designed for different purposes—Vampire as a jet interceptor, Hornet as conventionally powered carrier fighter.



Top. Underside view of new Goblin-powered DH Vampire jet fighter gives a good idea of craft's wing plan, also shows intakes for turbine. Jet exhaust is at rear of fuselage nacelle. Long chord ailerons are also noticeable. Photo immediately above depicts cockpit placement and shows details of small tail assembly and high-mounted elevator. Four 20-mm. nose cannon make up armament, and top speed is given as "over 500 mph." (British Official photos)



R-R Merlin powered DH Hornet was put into production as a carrier-based fighter for use against Japs. Resembling the famed Mosquito, single placer has a given top speed of over 470 mph. and a range of more than 2,500 mi. with extra tanks. Maneuverability was improved by having four-blade propellers turn in opposite directions. Craft is of composite wood and metal construction.

TWO NEW DE HAVILLAND fighters, the 100 Vampire and 103 Hornet, each claimed to be the fastest in their class, were being readied for action in Pacific when war ended.

Believed to be the first twin-boom jet-fighter yet made, the 500-mph.-plus Vampire is powered by a single DH Goblin turbine fitted in the fuselage behind the pilot, with air intakes mounted in the wings near the fuselage, and outlet located in the rear of the nacelle.

Construction is all-metal, except the cockpit, which is a wood carapace structure, similar to that of the Mosquito. Cockpit, located forward of the leading edge, offers fine visibility. Elevator and fin are set high between the twin rudders in order to escape blast effect of the jet.

Tricycle retractable landing gear is employed, with main wheels folding outward. Four 20-mm. cannon are set low in the nose. Span is given as 40 ft., length as 30 ft. 6 in., height 9 ft. 9 in., and wing area 258 sq. ft. Performance figures have not been revealed.

Stated to be the world's fastest propeller-driven craft, the new Hornet appears to be a scaled-down Mosquito, and was designed to operate from carriers. It is stated that the prototype flew just twelve months after the design work began.

Fuselage is all-wood carapace construction, but the wings are a composite of double upper plywood skin and underskin of alloy, with composite wood and metal spars. Two Rolls-Royce engines of 2,070 hp. each extend well forward of the craft's nose. The port engine is a Merlin 130, and the starboard a Merlin 131, the only difference being a provision in one engine for having the propeller turn in the opposite direction in order to cancel torque.

Span is given as 45 ft., length at 34 ft. 6 in., wing area 361 ft., and weight as 15,000 lb. Craft's rate of climb is stated to be over 4,500 fpm. at sea level, and top speed is put at over 470 mph. Operational range, when fitted with long range tankage, is calculated at more than 2,500 mi., and operational ceiling is placed at 35,000 ft.

Closeup of two-place Ensign, developed by All American Aircraft, Inc., and aimed at $3,000 price bracket. Standard power plant is 85-hp. Continental, but optional units up to 115 hp. are to be available. Prototype has fixed tricycle landing gear, but retractable gear is also to be offered. For aerodynamic cleanliness, flush riveting is used throughout the craft.

Ensign Two-Placer Features Bubble Canopy

With emphasis on aerodynamic cleanliness, new personal craft slated for early '46 production utilizes many features learned in wartime manufacturing.

TENTATIVELY PRICED at $3,000 and with production slated to begin early next year, the two-place low-wing Ensign, produced by All American Aircraft, Inc., of Long Beach, Calif., is now undergoing test flights.

With side-by-side seats, the Ensign has a fighter-plane-type bubble canopy that slides aft from its junction with the windshield. Built-in ventilators and an optional light-reflecting coating of the upper part of the canopy are designed to give heat and sun protection without reducing visibility.

Full cantilever tapered metal wing has NACA 23016 section at the root and NACA 4412 at the tip. All-metal ailerons are Frieze-type without tabs.

Fuselage is semi-monocoque construction, with flush riveting used throughout.

Fixed tricycle landing gear is fitted on the prototype, but producers plan to offer retractable gear as an optional feature. Oleo shock struts are used on all landing gear wheels, and nose wheel is full castering. Hydraulic brakes are provided.

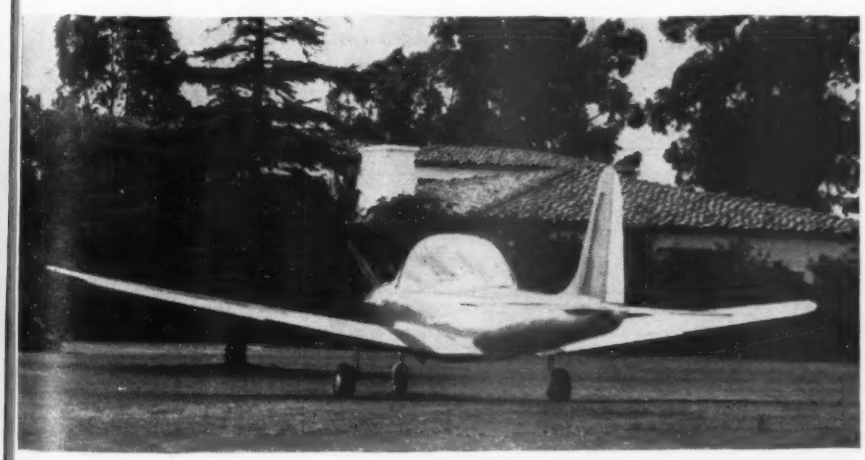
Optional power plants, ranging from 85 to 115 hp., will be available, with a Continental 85-hp. as standard. Standard propeller is a fixed-pitch Sensenich, but the variable pitch version will be offered as optional equipment. Engine cowling is designed for quick access to facilitate servicing.

Instruments are mounted in an automobile-type panel trimmed in plastic, and movable controls have plastic knobs. Standard instruments include: Compass, airspeed indicator, tachometer, fuel pressure and quantity gages, altimeter, and oil pressure and temperature gages — a well-planned group.

An automobile-type seat, adjustable fore and aft, is upholstered in deep blue or red leather, matching the balance of the cockpit and the trim colors. A leather-lined baggage well, measuring 18x42x24 in., is set behind the seat.

Controls are operated by either direct cable or push-pull rods, eliminating pulleys and giving what is said to be a greater degree of feel than would otherwise be possible.

Gerald Adler, president, reports the company is tooling for production of as many as 5,000 craft during 1946. Sales will be handled by direct factory representatives.



Three-quarter rear view of Ensign showing fighter-type bubble canopy. Special light-reflecting coating may be applied to top part of canopy to give protection from sun without reducing visibility.

Specifications and Data

Span	33 ft.
Length	23 ft.
Height	8 ft. 6 in.
Wing area	140 sq. ft.
MAC	52 in.
Wing section, root	NACA 23016
Wing section, tip	NACA 4412
Gross wt.	1,450 lb.
Wt. empty	900 lb.
Wing loading	10.3 lb./sq. ft.
High speed	125 mph.
Cruising speed (70% of power)	112 mph.
Landing speed	50 mph.
Rate of climb (SL)	700 fpm.
Service ceiling	13,500 ft.
Range	500 mi.
Power plant, standard equip.	85 hp. Continental

BOEING STRATOCRUISER AIMED AT LOW-COST OPERATION

All-purpose passenger-cargo craft being developed from B-29 Superfortress is designed for versatility of operation, with ease of maintenance an efficiency factor.

LATEST ENTRY IN THE heavy-duty passenger-cargo transport field is the Boeing Stratocruiser, being developed from the Army C-97 which was, in turn, developed from the B-29 Superfortress.

Called an all-purpose craft by Boeing engineers, the Stratocruiser can accommodate up to 114 passengers or 39,000 lb. of cargo at a cruising speed of 340 mph. and, since it can carry 43 percent of its 130,000-lb. gross weight as useful load, it can profitably meet present airline rates with only a 20 percent load factor.

The Standard Stratocruiser has seats for 67 passengers plus 900 cu. ft. for cargo. Reached from the top floor by means of a circular staircase is a 14-seat lounge in the bottom deck. The operator may sell space in the lounge, bringing the capacity to 81, or he may offer, as a luxury service, the lounge as an "observation car" for change in passenger surroundings.

The Commuter version uses both upper deck and lounge for passengers, totaling 114. Like the Standard version, 900 cu. ft. of space is available below for cargo.

The Sleeper has 30 berths plus one additional seat and the 14 seats in the lounge. By day, it has 65 seats exclusive of the lounge, and 900 cu. ft. of cargo space. As a "half and half," the craft can carry 71 passengers on its upper deck, with 1,400 cu. ft. of space for cargo below.

Finally, there is the All-Cargo Stratocruiser, which has 5,720 cu. ft. available for payload, 4,320 cu. ft. on the upper deck and 1,400 below.

Passenger versions have large dressing rooms and coat compartments in addition to coat and luggage racks, and a galley. The lounge has facilities for snack or bar service.

In all versions, the flight control cabin has provisions for a flight crew of from three to five, according to the needs of the operator. Unusual features of this cabin are a steerable nose wheel, a common (single) set of engine, trim tab, and miscellaneous controls for pilot and co-pilot, and line-of-sight installation of most-frequently-referred-to instruments. An unusually high degree of pilot visibility is attained.

All accommodation and utility areas of the Stratocruiser are both altitude and air conditioned. A combination of radiation and convectional heating facilities drives warmed or cooled air up the side walls between the lining and soundproofing (also between dual-glass windows throughout to end frosting and steaming) and through ceiling grilles. The system can maintain a 73-deg. F. temperature at outside air conditions as cold as 70 below and, for cooling, inside temperatures 10 deg. below ambient. These conditions can be maintained on the ground with the engines inoperative and the plane independent of all ground installations.

Air and altitude conditioning systems as well as the entire electrical system and thermal anti-icing for wing and empennage, operate from an auxiliary

Boeing Stratocruiser main cabin mockup, showing how Standard version seats 59 passengers. Another compartment forward has space for 8 more, and 14 additional can be accommodated in lounge on lower deck. This arrangement also provides 900 cu. ft. of cargo space. A Commuter model, designed for shorter hauls, can accommodate 144 passengers and cargo. (Boeing Aircraft photos)

End of Stratocruiser lounge. Also readily arranged as snack bar or cocktail facility, lounge is located on lower deck, and it is connected with main cabin by circular stairway.

Designed for overnight intercontinental service, Boeing Stratocruiser has room for 28 berths in main cabin. Five additional passenger can be seated in smaller compartment on upper deck, and 14 in lower deck lounge. Stratocruiser is being developed from Army C-97, a double-deck cargo-paratroop carrier developed from B-29 Superfortress.

power plant—actually two units—located in an outboard nacelle lower fairing and each capable of performing all normal functions alone. Gasoline-driven, they draw fuel from main engine tanks in the inboard wings.

The pressurization system functions from the moment the doors are closed. Automatically following a pre-determined flight plan in most cases independent of that actually being flown by the airplane, the cabin is gently "lifted" as the Stratocruiser assumes altitude, and is "cushioned" in descent. Up to 15,000 ft. cabin atmospheric conditions can be maintained at sea level. Inside conditions at 20,000 ft. are those of 3,000 ft. above sea level; at 25,000, inside conditions are 6,000; and at 30,000 ft., the cabin is at 8,000.

Wing spars are of web type with extruded chords. Interspar ribs of the inboard wing are built up with webs, channel stiffeners, and chords, while those of the outboard wing are of pressed metal type. All nose and tail ribs are also pressed metal. Heavy gage skin, reinforced by extruded spanwise stringers, is used to prevent wrinkling under load. The airplane has large Fowler-type flaps.

A relatively simple combination of longitudinal stringers and circumferentials, together with their components, makes for strength in the fuselage, was designed to withstand fully all pressures encountered in altitude conditioning.

Flush rivets and butt joints are employed throughout the craft, and spot-welding has been extensively used.

Each of the four Pratt & Whitney Wasp Major engines may draw fuel from its designated tank group or from a manifold line into which any or all tanks can be discharged as desired. The wing-carried fuel cells have a total capacity of 5,860 gal. A 1,195-gal. wing center section installation ups this total to 7,055. Under special loading conditions with external cells, total fuel capacity is 8,225 gal. Each tank group is discharged to the fuel distribution system through a booster pump, which assures freedom from vapor lock and loss of pressure at all altitudes. Every booster pump has selective speed controls to satisfy variable altitude and starting requirements.

Fuel tank quantity gages, boost pump controls, fuel pressure gages, and tank selector valve controls are coordinately arranged on a functional control panel, which also serves as a fuel system diagram. Thus the desirable procedure for any situation is at once obvious without the necessity of reading instructions and making a mental analysis of valve and pump control manipulations. Quantity indicators have big dials with large divisions for accurate reading. Gages are electronic with tank elements located so as to minimize errors due to roll or pitch.

Both engine power and engine accessory zones are covered by the fire protection system, which is so manifolded that the entire supply of fire extinguishing agent may be directed to a single nacelle.

Dual-wheel tricycle landing gear (augmented by a fully retractable tail skid for abnormal conditions) is electrically retracted, control circuits being actuated by a single landing gear switch. Oleo safety switches prevent the landing gear components from retracting while weight is on the wheels. A manual retracting system—fully independent of the main electric motors and control circuits but operable by a portable auxiliary motor as well as a handcrank—is provided for each main gear and the nose gear.

An ingenious system of elevator

(*Turn to page 257*)

THIS STORY OF THE NORDEN BOMBSIGHT POINTS THE WAY TO

IMPROVED PRODUCTS

AND

LOWER COSTS

WITH

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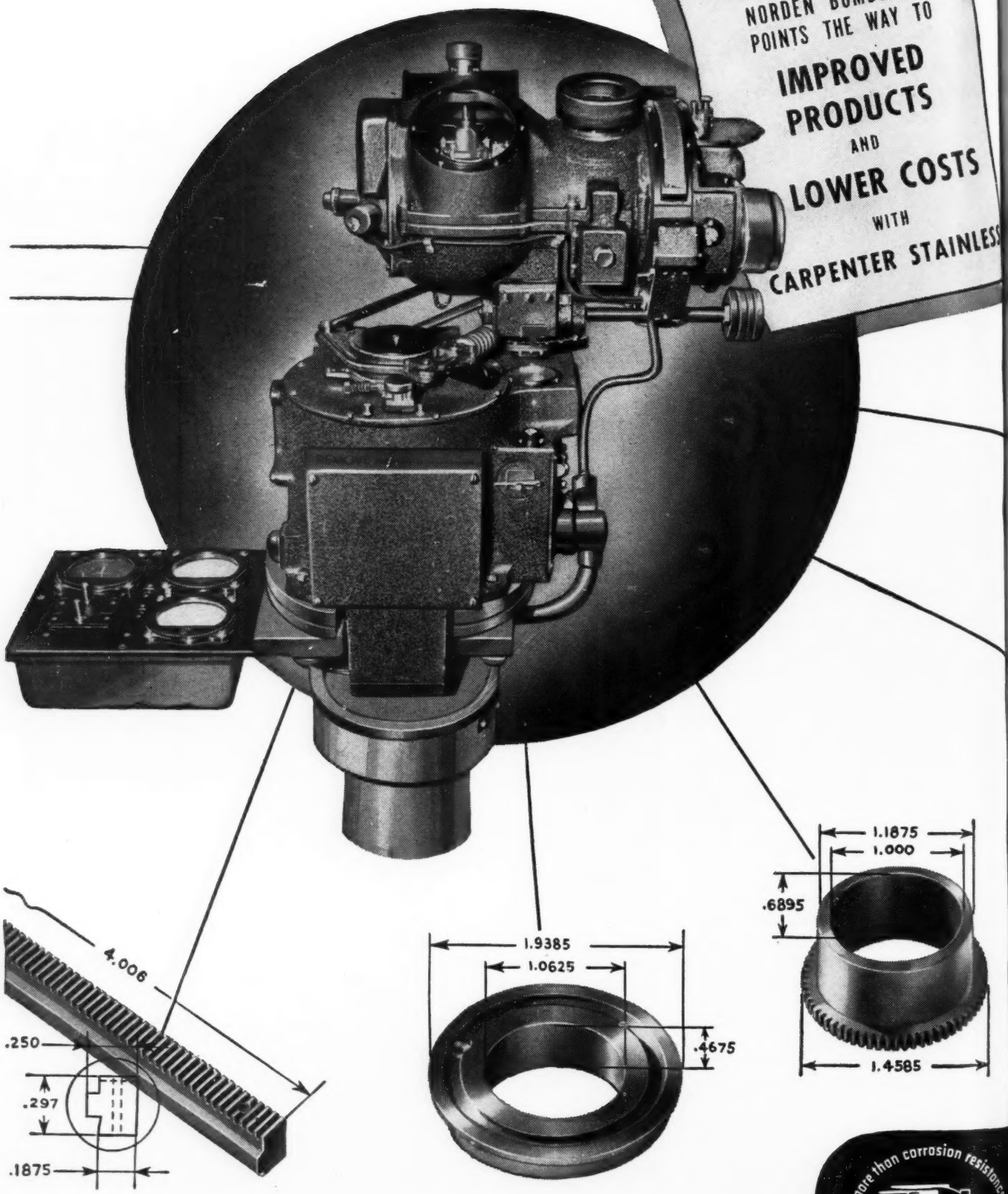

THE CARPENTER STEEL COMPANY, 128 W. Bern Street, Reading, Pa.

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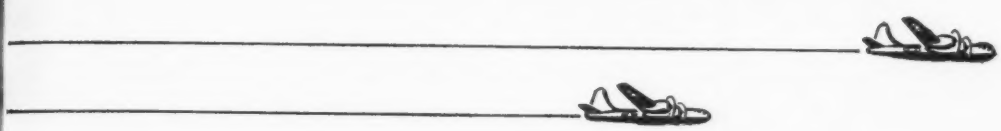
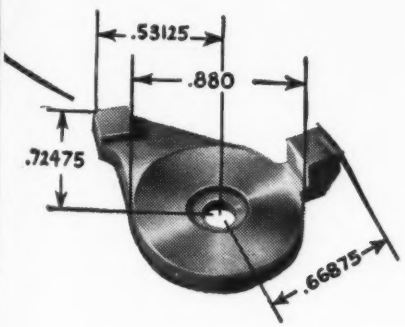
To Get *High Precision* Parts with *Fewer Rejects*



. . . use the Stainless that met exacting Norden bombsight requirements



● If ever a job called for close tolerances, plus product dependability, it was this famous bombsight.

The requirements were tough. For instance, one small piece —the heart and nerve center of the bombsight—was held to a tolerance of ±.0001". The part contained less than 1¢ worth of steel, yet was listed as an $8 cost item. Stainless was a "must" for this and many other vital parts, because corrosion resistance, wear resistance and a high strength/weight ratio were necessary.

Why Carpenter Free-Machining Stainless was first choice for these bombsight parts is a story that can now be told.

You can sum it up in one word—"dependability". Said one of the factory superintendents: "Experience with material obtained from other sources has convinced me that we have *less rejections, better machining time, less trouble* in straightening, and *better tool life* with Carpenter Stainless No. 5 bar stock."

Your own precision requirements may be less severe, but you will benefit by the consistent, money-saving uniformity of Carpenter Free-Machining Stainless. Made to tool steel standards in a tool steel mill, Carpenter Stainless guarantees top-flight performance.

Try Carpenter Free-Machining Stainless Steels and see what a difference they make in your production set-up. Your nearby Carpenter representative will gladly help you in solving your Stainless problems. Call him or write us at the mill.

Carpenter STAINLESS STEELS

BRANCHES AT Chicago, Cincinnati, Cleveland, Detroit, Hartford, Indianapolis, New York, Philadelphia, Providence, St. Louis

Considered to be one of Germans' best operational craft, this Junkers Ju-388 is a four-place night fighter and bomber powered by two 1,650-hp. BMW 801's, which gave this craft a 362 mph. top speed at 40,300 ft. Above 8,000 ft., cabin is pressurized by turbosupercharger, and there is supplemental ram air drawn into cockpit. (ATSC photo)

NAZIS BRINKED THE FANTASTIC IN DRIVE TO RE-COMMAND AIR

A COMPREHENSIVE firsthand view of German wartime aviation research and design may be had by visiting ATSC's new foreign equipment evaluation center at Freeman Field, Ind., commanded by Col. H. C. Dorney.

Here the AAF has been gathering samples of every type of Nazi equipment, ranging from complete aircraft, through power plants, instruments, weapons, ground-laying radar, and thousands of other items. And with the aid of imported German technicians, thorough tests are being conducted to learn the value of this material in relation to our own developments. Special attention is given to new projects, many of which were in early experimental or bench-test stages when our forces captured the German facilities.

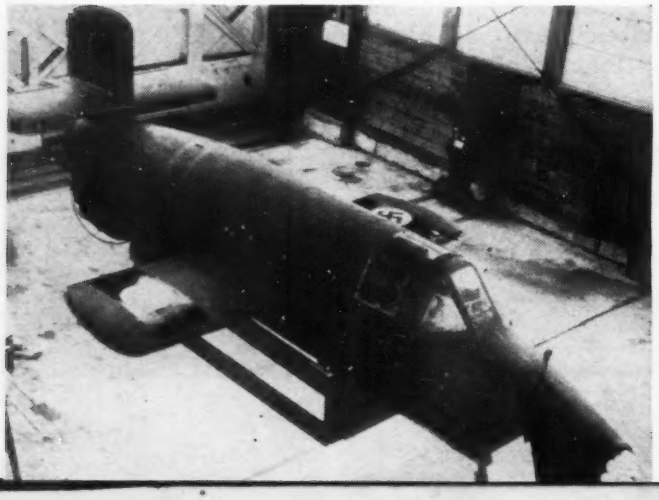
Frankly, some of these projects bordered on the fantastic. So intense was Nazi research that it appears that no idea was considered impossible once a chance was recognized that it might help in developing a knockout or delaying blow against the Allies. In fact it is believed that this very broad program was a factor in delaying the Germans in gathering an effective aero arsenal. Resources were spread so thin, in the attempt to cover every possibility, that some estimates place the resulting lag between practical research and production as at least two years.

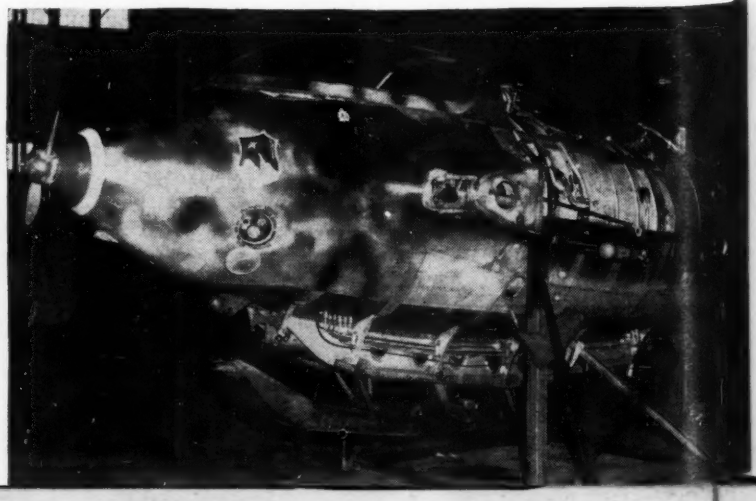
Aircraft

One of the aircraft types that our bomber formations narrowly missed encountering was the Bachem BP-20

Bachem BP-20 Natter was a semi-expendable one-place rocket-powered interceptor with which Nazis planned to disrupt our bomber raids by laying down a dense fire pattern within formations. Initially controlled by ground radar, craft had 37,000 fpm. rate of climb after being launched from vertical ramp. Pilot was to take over at altitude and fire 24 nose-fitted rockets. (Press Assn. photo)

Here is Messerschmitt Me-163B rocket interceptor, now undergoing examination at ATSC's Freeman Field in Indiana. Built with wooden wings and metal fuselage, craft has a 12-min. endurance and 550-mph. top speed. Note retractable landing skid which was used after wheels were jettisoned. Small nose propeller supplied power for generator. (ATSC photo)





Heinkel He-219, powered by two DB 603 engines in circular cowlings, has a top speed of 385 mph at 21,000 ft. Crew of two sits back to back, and there is an emergency seat in rear of fuselage. Heavy armament consists of four nose 20-mm. cannon plus two 30-mm. cannon fixed behind cockpit to fire upward at 65 deg., and there are provisions for two more guns in wingroots. (ATSC photo)

Natter (Viper), a cheap, semi-expendable, short-range one-seat rocket-propelled interceptor. It was devised after a careful study of photos of American bomber formations showing their width and depth. From these studies the Germans gaged a cone of fire intended to destroy enough craft to render impractical any further such raids by the Allies. The BP-20 was to be midway between a guided missile and a man-controlled fighter plane. Launched from a vertical ramp and using auxiliary takeoff units, the craft was to have an initial rate of climb of 37,000 fpm. This terrific speed would have rendered human control impossible—so initial flight would have been controlled by ground radar.

Leveling off in the center of the bomber formation, the pilot would weave his Natter around and fire off the 24 Fohn 7.3-cal. rocket projectiles set in the craft's nose. Extremely heavy cockpit armor was to be fitted.

After the rockets had been fired the pilot could eject himself from the craft and come down by parachute. The rear of the fuselage, containing the rocket power unit would break off and also parachute down, to be refueled and refitted to another fuselage for further use.

Of all-wood construction, Natter would have taken only 600 man-hours to build. Span was to be 13 ft., and length 30 ft. 6 in. Horizontal tail surface controls would act together or differentially as ailerons. Top level speed was planned at over 600 mph. at 16,000 ft., and range at full power was set at 80 sec., or 2 min. under normal power.

Radical jet- and rocket-propelled fighter aircraft were brought through development stage despite Allied bombing and they might have changed air power balance had production kept pace.

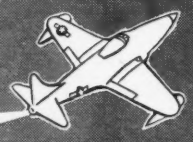
Another unusual, though somewhat more conventional, fighter was the Dornier Do-335, fitted with two DB 603E engines in tandem, one in the nose and one in the tail, turning oppositely rotating propellers. A number of versions of this craft were built, some as two seaters. Also one model was planned which was to be a composite, i.e., two Do-335's joined together at the wings.

Top speed was gaged at 475 mph. at 21,000 ft., while range was put at 828 mi. and landing speed 109 mph. Night fighters had two 20-mm. cannon mounted in the cowling firing forward and one 30-mm. cannon in the propeller shaft. The day fighter was equipped with three 30-mm. cannon and two 20-mm. cannon. Span was about 45 ft., length about 45 ft., height 16 ft., and wing area 414 sq. ft. Tricycle landing gear was used, with wide-track wheels folding inward, while nose wheel folded back. The latter turned through 45 deg.

Credited with building the first jet-propelled aircraft to fly successfully (the He-178, flown Aug. 1939), Heinkel had started production of the He-

Flettner Fl-282 is two-place co-axial twin-hub helicopeter designed for observation purposes. Powered by an SH-14 radial engine of 150 hp., craft has a 100-mph. top speed and 15,000-ft. ceiling. Passenger sits backward in cockpit just behind rotor hubs. (Aviation staff photo)

JET PROPULSION TURBINES by BROACHING

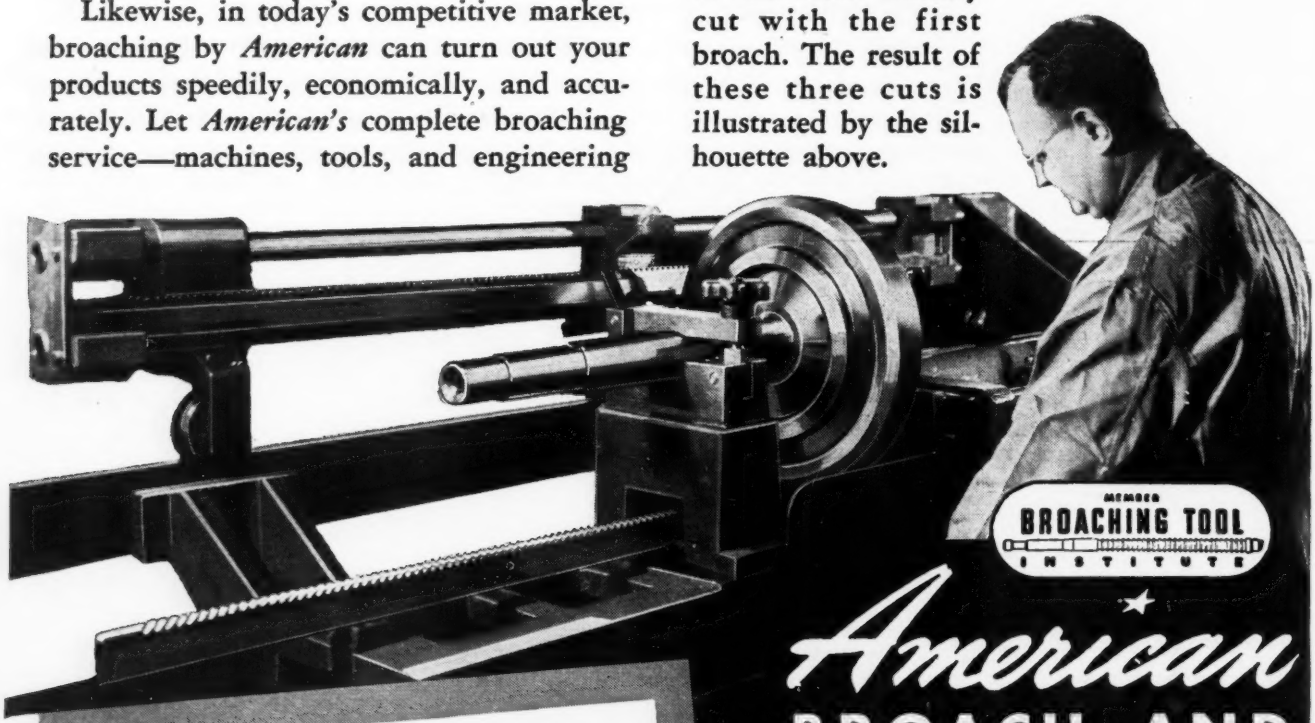


Step 1

WAR PRODUCTION, with its emphasis on speed and precision, proved beyond a doubt the unequalled speed and accuracy of broaching. For example, the typical wartime problem shown below was the exact shaping of slots in jet propulsion turbines. Broaching by *American* delivered the turbines much faster than would have been possible by any other method.

Likewise, in today's competitive market, broaching by *American* can turn out your products speedily, economically, and accurately. Let *American's* complete broaching service—machines, tools, and engineering—help solve your manufacturing problems. Write today for details.

An *American* HD-15-66 Horizontal Broaching Machine (below) was used to broach starting slots in jet propulsion turbine wheels. Employing a set of two broaches, two cuts were made with the first, and one cut with the second — the second broach deepening one of the slots already cut with the first broach. The result of these three cuts is illustrated by the silhouette above.



WATCH THIS PAPER for the next operation in broaching jet propulsion turbines. Step 2—Semi-Finishing—will be described in American's January advertisement.

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162 Volksjager, a one-place interceptor powered by a BMW 003, rated at 1,760 lb. static thrust at sea level. This small craft has a wing span of only 24 ft., length 34 ft., and 120 sq. ft. of wing area. Top speed has been estimated at 522 mph. at 19,700 ft. and maximum range 242 mi. Gross weight is 5,940 lb.

Wing construction is of wood, and attachment is by means of four bolts to the fuselage. Space between the spars is used for fuel tanks. The fuselage is all metal semi-monocoque construction, flush riveted throughout. Main compartmentation of craft comprises cockpit and facilities for armament, fuel tank, and undercarriage. There is another fuel tank in the tail cone.

Unusual feature of the He-162 is the placement of the power unit on top of the fuselage just behind the cockpit. This necessitated a twin-tail assembly with elevators and fins having decided dihedral. Tricycle landing gear is fitted and all wheels fold into the fuselage.

Messerschmitt's Me-163B interceptor is powered by a Walter 109.509 liquid-rocket unit mounted in the tail. This power plant is made in two assemblies, the forward comprising a turbine mounting, two worm-type fuel pumps, a control unit, pressure-reducing valve, and electric starter motor. A small cylindrical unit attached to the forward housing produces steam to drive the turbine through action of a solid catalyst on hydrogen peroxide. The other assembly is made up of the combustion chamber. Fuels used are concentrated hydrogen peroxide and a solution of hydrazinc hydrate in menthol.

Jettisonable twin wheels are attached to the Me-163B for normal takeoffs, and a retractable skid is used for landings. Span is about 30 ft., length about 19 ft., and wing area is 186 sq. ft. Top speed is given as 550 mph. at 20,000 ft. and over, and endurance is about 12 min. Normal weight is 9,500 lb. Armament comprises two 30-mm. cannon. A later model, the Me-163C, had an auxiliary cruising jet unit. This type, featuring a pressure cabin, was rated for a 590 mph. top speed.

Prof. Kurt Tank designed the Ta-183 for Focke Wulf, and this new jet fighter was ready for production in 1945. To be powered by either a Junkers Juno 004 or Heinkel O11 turbine, all fuel would have been carried in the structure of the all-wood, sharply sweptback wings. The jet unit was to have been mounted in the rear of the fuselage with the intake pipe passing under the cockpit. In another version, an auxiliary rocket unit was to be fitted for very rapid takeoff and fast climb.

Speedy little Heinkel He-162 is powered by a BMW 003 turbine in unusual turtleback position. Top speed is estimated at 522 mph. and ceiling at 39,400 ft. Construction consists of wooden wings and all-metal fuselage. Note wing tips bent down at 55 deg. Armament consisted of either two nose-mounted 20-mm. or 30-mm. cannon. (ATSC photo)

Junkers was also very busy on a number of turbine-powered types. One of these was planned as a flying wing, powered by four centrally-mounted jet units and fitted with a retractable tricycle landing gear. Range was planned as about 3,700 mi. and top speed at 620 mph. Gross weight was to be 77-84,000 lb.

EF-126 was another of this company's projects. Designed as a small one-place ground strafer, it was to be powered by a single Argus-Rohr unit of 1,100 lb. static thrust at sea level, span was to be about 20 ft. and gross weight 6,160 lb.

FF-128 was to be a Junkers fighter of the tailess type with a jet engine in the center of the fuselage. Armed with four 30-mm. cannon, this craft was to have a 590-mph. top speed. Gross weight was set at 10,780 lb.

Remote control tail turret on Ju-388 mounted two 13-mm. (about 50 cal.) machine guns. This is believed to be one of first attempts by Germans to provide operational craft with this type of armament. (Aviation staff photo)

Mistel 5 was a projected Junkers composite, with the upper component to be a He-162 fighter. Carrying a warhead, the lower component was designated Ju-268 and was to be an all-wood monoplane with twin rudders. Tricycle landing gear was of the jettisonable type. With power supplied by two BMW 003 turbines, top speed was estimated at over 500 mph.

Power Plants

One of the more interesting engines now being studied at Freeman Field is the BMW 803, a 28-cyl. liquid-cooled radial fitted with two-stgae four-speed superchargers, and designed to turn an eight-blade contra-rotating propeller. It has the looks of two 14-cyl. radials joined together, with the cylinders of each unit built in seven blocks of two mounted radially about the crankcase. The two cylinders of each block have a common cylinder head casting and camshaft. This camshaft is driven by inclined drive shafts, the shafts being set at the front and rear of the engine.

Stated to produce up to 4,000 hp. on takeoff at 2,950 rpm., this plant has a bore and stroke of 6.14 in. and capacity of 5,095 cu. in.

Another interesting project, later abandoned, was a combination of two DB 603 engines and one DB 605. The 605 was to be mounted inside a fuselage to drive a two-stage compressor supplying induction air to the other engines set in the wings. This design was to produce 3,500 takeoff hp.

Klockner-Humboldt-Deutz were experimenting with the Dz-710, a 16-cyl. liquid-cooled two-stroke diesel, fitted with a turbosupercharger and having two opposed banks of eight cylinders delivering 2,700 hp. This engine was intended as a flat installation, and could also be combined in H form turning out 5,400 hp.

CIVIL OPERATIONS

How Slanting for Satisfaction Boosted Airport Business

Sullivant Airport, Administration offices, restaurant, and Snyder Aircraft Co. showroom are in white building at left, while three heated hangars are at right. Tower is used for lighting field for night landings.

By EDWARD E. THORP, *Assistant Editor, "Aviation"*

Convinced that pleased customers bring in the right kind of business—in "chain letter" fashion where every sale results in several more—Gomer Jones has made Sullivant Airport a popular spot which flyers really like to revisit.

WHEN PRIVATE FLYERS meet and talk shop, airports and their operators come in for plenty of candid criticism. The man whose service prompts his customers to boost for him speedily discovers that he has built an ever-growing asset of goodwill which will pay continuing dividends.

Analyzing the needs of itinerant pilots, Gomer Jones of Sullivant Airport, Columbus, Ohio, concluded that customer satisfaction is primarily influenced by the following factors: Quick and efficient fueling service; comfortable accommodations; good food at reasonable prices; fast and immediately available transportation to the nearest city; service by licensed mechanics, working in a heated hangar under clean conditions and with plenty of room around planes; and a good stock of parts to avoid delays in making repairs.

The first consideration is covered by arranging the fuel pumps inside a circular curb, enabling as many as six planes to refuel at once. Built below propeller level, this curb serves to prevent possibilities of collisions with pumps by in-running craft.

Pilot accommodations are taken care of by a large and comfortably furnished lounge, with rest rooms and roomy individual lockers capable of storing all the baggage likely to be carried in a plane. This service enables a visiting businessman to change clothes before making calls in the nearby city of Columbus. One result of this feature is that several oil companies and manufacturers now base their planes at the airport because of recommendation by pleased salesmen.

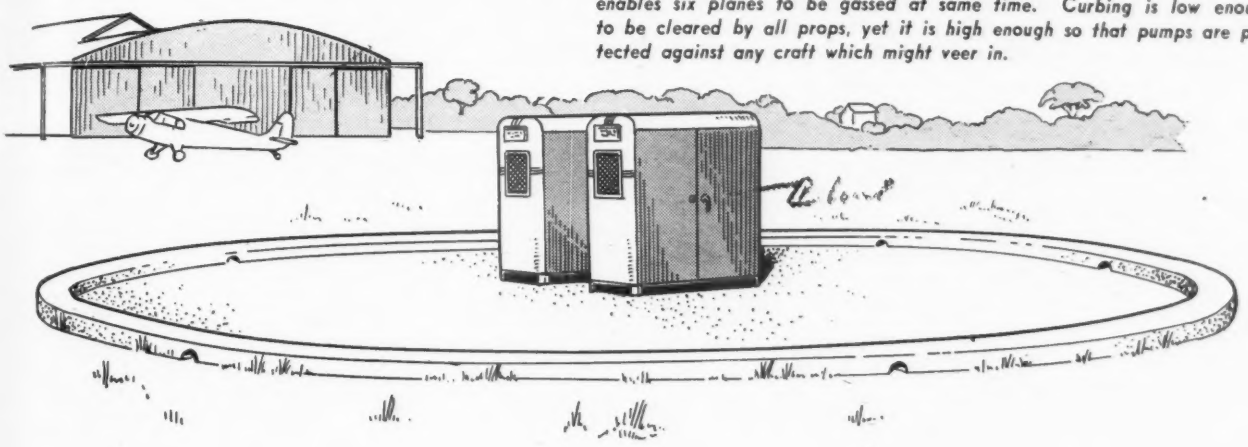
Free taxi service to the city bus terminal is provided to speed the traveler to his destination and pick him up on his return.

If a pilot just drops in for a meal, he finds a clean and comfortable restaurant in the administration building where satisfying food is served at reasonable prices. If he merely desires to rest or write letters, the lounge provides all the facilities he requires. In this room are posted flight plans of neighboring airports, giving traffic and approach rules, with which the flyer can familiarize himself while his plane is being serviced.

Three heated hangars provide shelter, and there is no danger through overcrowding since they are large enough to permit planes to be removed without delay. Adjoining engine and airplane repair shops, staffed by licensed mechanics and provided with adequate mechanical equipment, enable work to be performed quickly and efficiently.

Heavy investment in parts and accessories is unnecessary, because part of the premises is leased to Snyder Aircraft Co., which distributes these lines and keeps a complete stock at the showroom. This advantage allows a customer's plane to be repaired and put back in the air in the shortest possible time, avoiding the delays incident to waiting for repairs to be shipped in.

The airport plan—sent to pilots who request it—covers enough of the surrounding terrain to orientate those visiting the field for the first time. The traffic pattern—both entering and leaving—is indicated, together with flight altitudes. This plan also gives position and description of obstructions, also location of roads on three sides of the



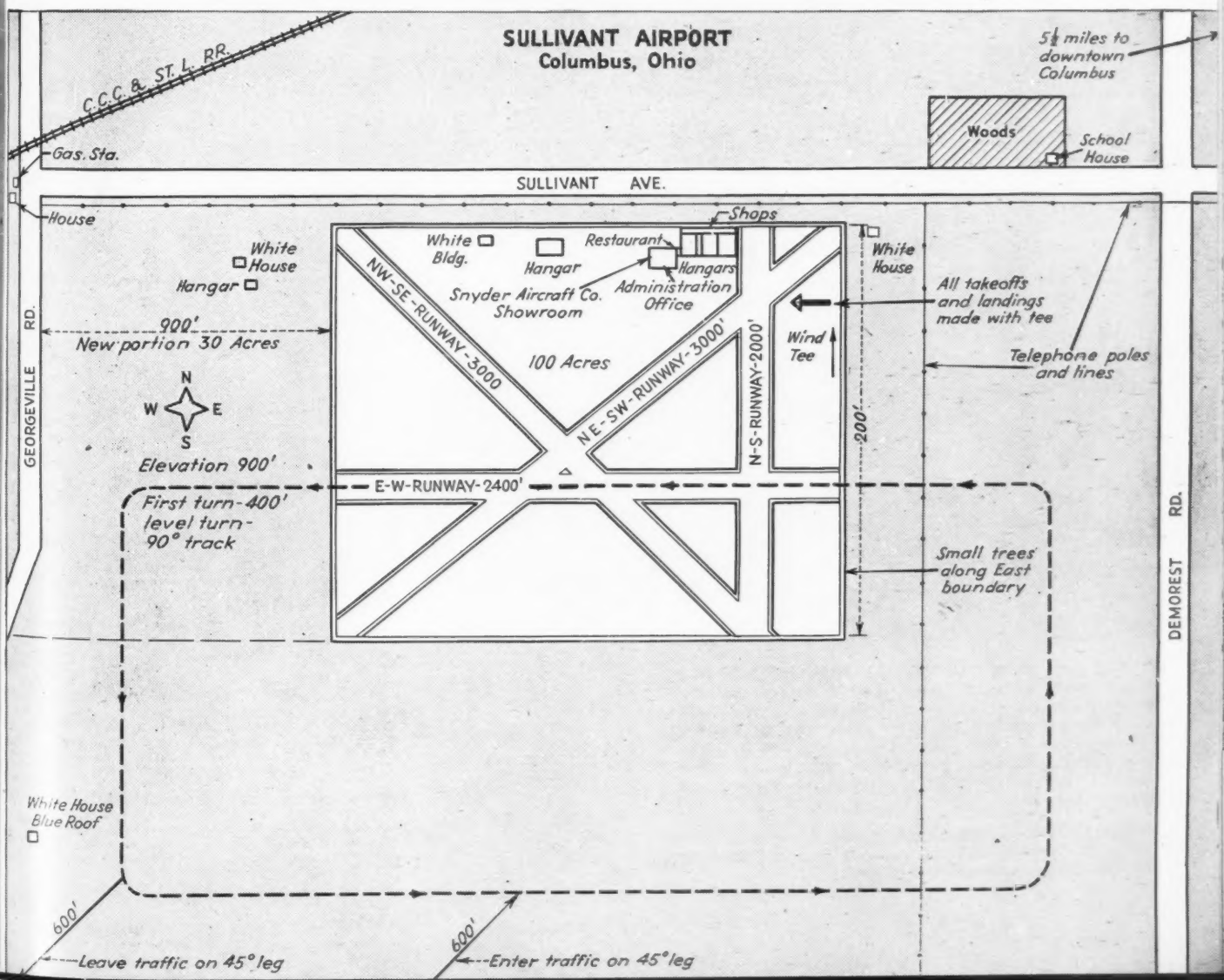
Circular base around fuel pumps takes place of conventional pit and enables six planes to be gassed at same time. Curbing is low enough to be cleared by all props, yet it is high enough so that pumps are protected against any craft which might veer in.

airport, making recognition from the air an easy matter.

Catering to the visiting pilot has not been overdone to the point of forcing other airport activities into the background. Flight training keeps two pilots busy, while the engine and plane overhaul departments employ 15 mechanics, several rated as specialists.

The field has four cinder runways, which have proven very satisfactory, their surface being self-draining under all ordinary conditions. Runways in direction of the prevailing winds are 3,000 ft. long, while the other two are 2,000 and 2,400 ft., respectively. This layout permits takeoffs and landings to be made directly in line with eight different directions of wind and renders it unnecessary to land at more than 23 deg. crosswind. Coupled with the fact that surrounding obstructions are low, this feature has contributed to the absence of landing accidents at this field.

Plan of Sullivant Airport gives runway location, flight pattern, roads, landmarks, and position of obstructions. Wind "T", placed near intersection of runways in front of hangars, permits easy observation before taking off. Position of restaurant beside highway invites passing automobile business. Single hangar is used for storage. Newly purchased portion of field is at west side of runway area.



TAGGING THE BASES

Urge Operators to Speak Up On "42" Changes

Further study of proposed Part 42 of the Civil Air Regulations is being urged by various state aviation leaders, it being held that the draft contains restrictions so drastic that they would affect the business of every operator. Curbs on single-engine planes are among the proposals. CAA has requested every operator to write for the draft, study it carefully, and send his opinions on changes or additions to Asst. Director Chamberlain, CAA Dept. of Commerce, Washington, D. C. The leaders point out that any fixed baser who fails to express himself on the changes will have no excuse for kicking if CAR 42 passes as proposed. (See story on CAR 42 in Second column, page 205, Oct. AVIATION.)

Group Activities Increasing

Disregarding any potential threats from legislation, the airplane is progressing from its wartime spectacular role and is entering everyday life. Reports from all over the country stress group breakfast flights, club dinners at airport restaurants, formation by employers of flight clubs among employees, airport social clubs, and group rides for high school boys and girls. These are signs that the personal plane is really headed toward attainment of family utility.

Wheeling, W. Va., Seaplane Base, operated by a former AAF pilot, Fred M. Rutherford, has been granted use of new Wheeling-Ohio Airport by Ohio County Commissioners.

Waukegan, Ill. Airport is completing two new runways with a view to making the field a port of call for flyers having business in Chicago. Wayne Carpenter of Waukegan Air Service, Piper agent, now has an airport car for transport of customers.

Buckwood Airport, between Bethlehem and Easton, Pa., has been opened by Stanley Woodward, with whom are associated J. M. Bouney of 539 Hamilton St., Allentown, also Vic Spano and Frank Bouton.

Hadley Airport, New Brunswick, N. J., operated by Thomas W. Robertson of Hadley Aircraft, Piper and Republic representative, reports that sales and flight instruction are highest in field's history. Shops have conditioned second Cessna UC-78 for Air Travel, Inc., of N. Y. C. and one for a Chicago customer.

Stewart Airport, Parkersburg, W. Va., Ercoupe distributor for Ohio Valley, W. Va., and Ky., is rendezvous for local chapter of Ninety-Nines, who recently held a reunion at the airport restaurant. Sponsor was Mrs. Stark of Charleston, W. Va. President.

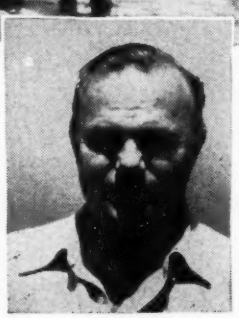
Springfield, Ohio, Airport, holding Aeronca and Republic dealership, has retooled repair shop and installed a new restaurant.

Ohio Aviation Trades Assn. met recently at Norton Field, Columbus, Ohio, to discuss proposed regulations for non-scheduled air transport, a national air taxi system, and a standard air traffic pattern for all airports. Officials are Foster A. Lane, chairman; J. R. Harrington, president; Geo. Wedekind, legislative; and Harry Pryor, membership. Lane Aviation Corp., field operator, is Republic distributor for central and S. E. Ohio.

Orange County Airport, Santa Ana, Calif., operated by Eddie Martin's School of Aviation, Ercoupe distributor, has recently completed overhauling a sixth plane for CAA.

Albuquerque's former CAP airport has been acquired by Lewis W. Graham and Wm. G. Bell. Three 2,700 ft. runways have been graded, and space has been allotted for private flyers to build their own hangars.

Breakfast flight group organized by L & D. Flying Service, Aeronca dealer at Prosser, Wash. Leaving at sun-up, flyers visit other fields in Yakima Valley, first stop supplying breakfast. Yakima, Toppenish, and Walla Walla were on itinerary of breakfasters seen above. Pilots (l. to r.) are: Ken Davidson, Bruce Forrest, Instructor Marc Seeber, Bob Neuman, Dick Weigand, Wiley Barrett, Wyatt Soderling, Paul Weaver, and Instructor Earl Smith.



Right: Bill Ong, of Ong Airport, Kansas City, Mo. For one thing, he's proving that Kansas really isn't dry by selling Republic Seabees throughout that state.

Chapman Field, Miami, Fla., is now headquarters for Embry-Riddle and will combine overhaul and school facilities formerly operated at other divisions of company.

Michigan Department of Aeronautics reports thefts of instruments from unhangared plane at Pontiac, also that an unwatched plane was flown away and has not yet been located. In another instance, young boys started up a plane's engine and attempted to take off. These incidents are cited as a warning to operators to take every precaution to prevent unauthorized persons from having access to planes or parts in their keeping.

San Diego County, Calif., has announced plan for $1,376,000 private airport improvements. Following fields are included in proposal: Encinitas, Rancho Santa Fe, Bear Airport at Linda Vista Mesa, Orr's Airport at Tecalote Canyon, Bibb's Airport at Linda Vista Mesa, Peik's Airport at Old Town, De Selm's Mission Valley Airport, La Mesa Airport, Shephard's Airport, Agan's Airport, Young's National City Airport, San Ysidro Border Airport, Volfe Airport at Chula Vista, La Pressa Airport, Hansen Airport, and Lakeside Airport. Costs of proposed improvements range from $11,000 to $210,000.

Allentown-Bethlehem, Pa., Airport, run by Wiley Post, Jr., of Lehigh Aircraft, reports that commercial and instrument flight instruction is on increase with a number of recent graduates going to commercial positions. From Colombia, S. A., came one student for instruction prior to becoming captain for Avianca. The Airport Social Club has taken over old CAA building. One feature of club's activities will be breakfast flights.

Spokane, Wash., reports that there is a shortage of experienced mechanics, because of recent greatly increased interest in flying. Wallace Flying Service, Hilsen Aero Co., and Lamb Flying Service (Taylorcraft distributor) report that over 300 residents are now taking lessons, with about 10 licenses being issued per week.

Oakland, Calif., Municipal Airport is now sales headquarters for R. P. Bowman, Stinson distributor, and West Moreau, who sells Taylorcraft.

Sky Harbor, operated by Central States Aviation at Wheeling, Ill., and under management of Harold C. Mattes and Wm. Turgoen, has taken a contract for converting twelve twin-engine Cessnas, two of which have been placed in service. Organization includes C. A. Helsing, Chicago, pres.; John H. Wilson, v.-p. and sec.; and Herman Krissman, treas.

Bob Trader, of Pittsburgh, suggests following system for taking loss out of short-time flights: Charge $1.50 for taking plane out, plus $5.50 for actual flight time, totaling $7 for 1 hr. This would work out to $2.42 for fellow who goes up for 10 min. just to show girl friend that he really can fly—not too high a charge, considering that work involved is just as much as if plane had stayed out for full hour.

Bendix, N. J., Airport has leased former Fokker factory to Robinson Aviation as complete base for private and business planes. In addition there are maintenance shops for Robinson Airlines, operating between Ithaca and N. Y. C. Operation building will contain lounge and restaurant, while office will provide phone and stenographic service for flying businessmen.

South Carolina Aviation Trades Assn. was recently formed to promote development of private aviation in state. President is R. F. Turner of Columbia; v.-p. is W. S. Scott of Charleston; and Walter Phipps of Columbia is sec.-treas.

Beech Aircraft announces that Hawthorne Flying Service, Orangeburg, S. C., has been appointed sales representative for most of N. C. and S. C., Eastern Ga., Washington, D. C., and several counties in Va. and Md. Hawthorne will appoint distributors and dealers in this territory.

Symbols of Victory

HISTORY will record airpower as the dominant force that brought Peace to the world.

Down through the ages...echoing the corridors of Time, Americans of all generations will pay tribute to the men of this generation who wore wings, and to those who serviced and maintained the planes they flew.

The workers of the aircraft industry...the people who designed and built those planes...join the nation in acclaiming your glorious contributions to victory.

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AIRPORT PLANNING MUST GATHER IMPETUS

By **ERWIN J. BULBAN**, *Editorial Assistant, "Aviation"*

Planning and construction of air terminals has trailed aircraft design and production. Still, promise is seen in the statistics and graphics of latest airport plans, both here and abroad.

ALTHOUGH the end of the war found us with a number of splendid and well-proven airliner types, along with designs that show much promise, construction of air terminals suited for these craft and for the predicted air traffic has been woefully deficient. In fact, airport building all along the line—for super transports down to the smallest personal craft—is in urgent need of expansion with sound planning.

Lack of a concerted airport policy has, up to now, been one of the major drawbacks to all types of commercial flying. A tremendous airport program was undertaken by the armed services during the war and hundreds of large fields and facilities were built. But these were air bases located in accordance with military necessity and often built in centers of large temporary military populations. Hence many of these locations are uneconomically placed and so are unsuited for profitable commercial use.

However, the picture is not altogether discouraging. Some communities and agencies have been aware of the situation and are trying to improve or establish high standard facilities.

Federal Aid

Most of the plans are being thrashed out independently among the major cities already established as air transport terminals. However, the CAA and other agencies are trying to establish a uniform system to insure better distribution of airfields throughout the country. Sought, too, are more fitting standards.

According to CAA, applications have been filed to bring airline services to 678 locations. But of these, 29 percent need new airports, 57 percent need improved fields, and only 14 percent now have adequate facilities. Of 299 locations presently designated for airline service, 4.7 percent have no airports, 2.3 percent need replacement, 57 percent are in need of improvements, and 36 percent are considered adequate.

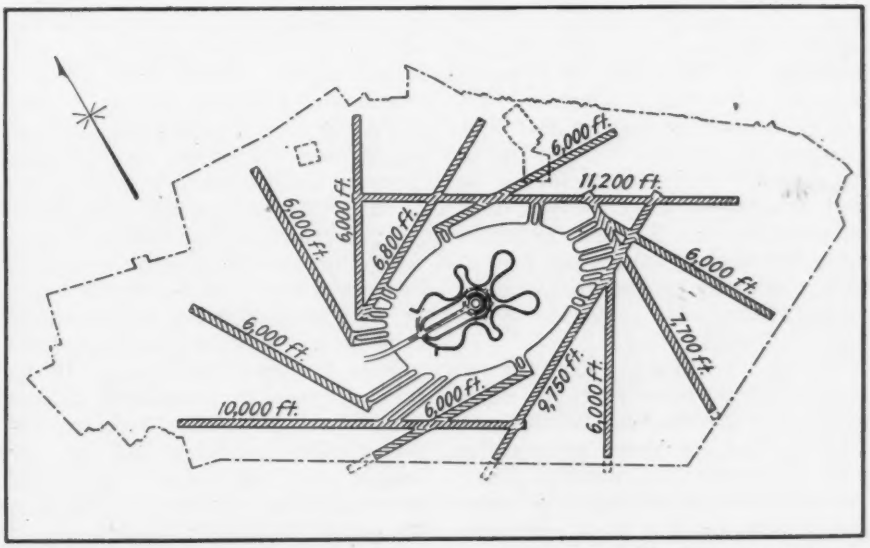
Under the Lea Bill, the Government proposes the construction of 3,050 new airports of all types—including those for personal flyers—and improvement of 1,625 existing sites, at an estimated cost of $1,250,000,000. An appropriation of $3,000,000 is sought for surveys and other preparatory work.

CAA contends that these would be sound public works providing about 1,250,000 man-months of employment, and upon completion these airfields would furnish employment for approximately 63,000 persons. Other points made are that they would be of great value to the national defense, would provide useful community improvements, be of permanent value, encourage private investment, cut cost of public transportation, and invite participation of non-federal governmental agencies.

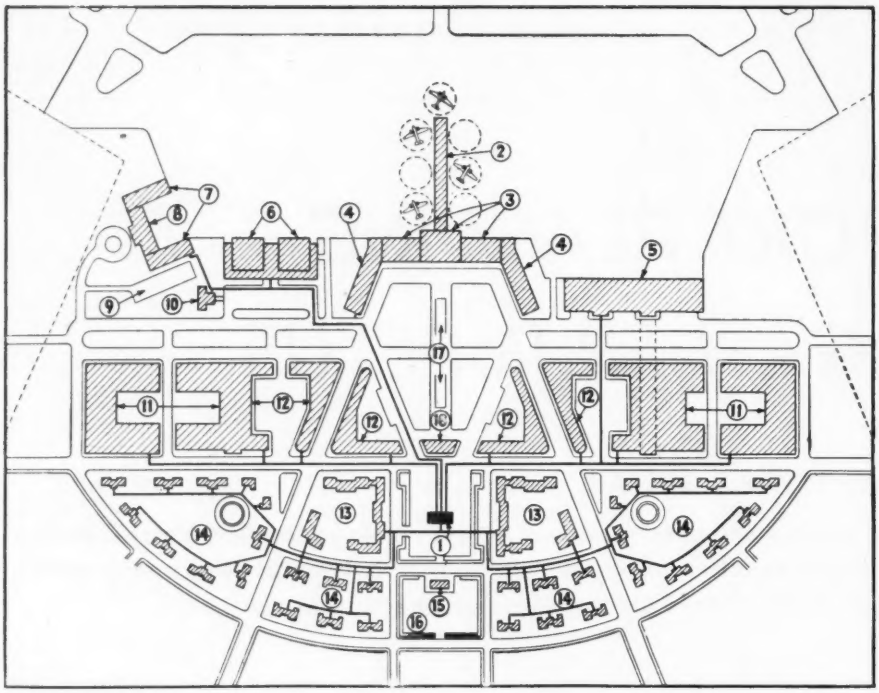
What the CAA would attempt to do is make metropolitan air terminals more accessible to the flying public. The agency claims that most big air terminals have been located in areas where land cost was low, rather than being placed conveniently to cities. Survey show that 1 hr. 40 min. is the average ground travel time consumed in connection with conventional air trips.

Super Air Terminals

The spotlight is focused on what the larger cities have on the way. In mind is the super-terminal, capable of hand-



Municipal airport now under construction at Idlewild, N. Y., is indicative of U. S. future terminal design, with administrative facilities at hub and large number of 6,000-10,000 ft. runways so arranged that simultaneous landings and takeoffs will be possible.



Airport plan that could be utilized by several communities interested in pooling common interests to provide service for all. Industries and housing project would be included in compact unit. Facilities are: (1) Boiler plant, (2) loading platform, (3) administration building, (4) hotel, (5) cold storage and express warehouse, (6) hangar, (7) personal plane hangar, (8) club, (9) parking area, (10) pumping station, (11) factories, (12) offices and shops, (13) apartment houses, (14) private homes, (15) pavilion, (16) playground, (17) parking, and (18) service station.—(From study by Ric-Wil Co., Cleveland)

ling the largest craft, with plane movements running into hundreds hourly. These fields are to be so big that construction is scheduled in stages, each complete in itself, over a period of years. They are planned to bring their cities millions of dollars monthly as a direct result of increased air transport business.

An excellent example of this type of planning is the new municipal airport being built at Idlewild by New York City. Designed to cover 4,527 acres, with runways capable of landing craft weighing up to 150 tons, and including provisions for 40 hangars, it is estimated that a staff of 40,000 will be required to operate this field. Contemplated is a further addition of 300 acres. When the field reaches its final construction stage in 1950, it is estimated that it will be able to handle up to 360 flight schedules per hour at peak. This may be compared with the present 400 daily schedules at La Guardia Field.

It took 3 yr. of study to devise the impeller design runway pattern which will permit simultaneous landings and takeoffs, now considered necessary in view of expected traffic increase. There are to be 9 mi. of landing strips—each 300 ft. wide and 1 ft. thick. The seaplane basin is to be 15,000 ft. long.

A $10,000,000 administration building, containing space of over 1,000,000 sq. ft., will be capable of handling 30,000 passengers daily. Together with loading decks, parking spaces, and apron, the clover-shaped structure will cover well over 300 acres. Travel from mid-town Manhattan to the terminal by car or bus will take about 26 min. Cost is placed at $71,000,000, with interest and amortization at about $2,600,000 yearly.

Medium Cooperative Design

For communities not likely to attain the volume of transport planned in the Idlewild project, but which yet would be influenced by a large increase in domestic and feederline traffic, a plan might be evolved wherein several neighboring cities could pool common interests and resources to build a regional airport serving all. This is the "airport center" type of design.

To justify such an arrangement, a total population of about 100,000 would be most practical. The project would combine facilities for trunklines, feederlines, and personal flying. In its primary stage, the community airport would have two large hangars, administration building, and an air freight and cold storage warehouse having loading platforms facing onto the apron. To one side would be a pair of hangars serving personal flyers, also a clubhouse. A conventional triangular runway pattern would be used. Hotel accommodations, automobile service station, and underground garage facilities would be among the conveniences included.

Featured in this design is to be a carefully planned and strictly zoned industrial area and housing project. The industries would probably be those most suited for using air transportation as a means of moving their products. The housing unit would include apartments, private dwellings, stores, and playground.

A central boiler plant would serve the airport, homes, and factories. It would also be possible to extend this facility to keeping the runways clear of snow and ice through a network of subsurface piping.

Conforming to CAA specifications covering a Class 3 airfield, the project would be capable of handling craft of 10,000–50,000 lb. gross weight. Paved runways would measure 200 ft. wide and 3,500–4,500 ft. long, with alignment to cover 80% of wind directions.

According to CAA there are only 478 Class 3 airports. Under the new airport bill, the Government would undertake to improve 349 of these and build another 101. A goal of 654 Class 3 fields is sought.

For Personal Flying

CAA estimates that with 10 yr. there will be 400,000 personal craft being flown in this country. At present, there are about 1,148 Class 1 and 869 Class 2 airports available. The agency claims that most of these are poorly located, with many not up to standard. Need is seen to improve 303 and build 1,806 of the former class, and improve 699 and build 1,101 of the later to be prepared to handle the expected traffic, and seen required is a 100-plane capacity.

Class 2 airports are designed to serve 5,000–25,000 population and would be able to handle craft weighing between 4,000–15,000 lb. Runways must be paved, must be 2,500–3,500 ft. long, 150 ft. wide, and so aligned as to cover 75% of winds.

A typical example of facilities being planned for personal flyers is the former Hartung Airport near Detroit (Gratist Ave. and 10½ Mile Road) being rebuilt by the Detroit Aviation Corp.

Redesign of the 4,000x1,600-ft. sod-covered field has been undertaken by The Austin Co. A new building is to house service and parts departments, sales display room for new craft, and a luxurious lounge overlooking the field for the convenience of family members who wish to watch the flying. Also contemplated are a new restaurant and more hangars.

An important factor in this airport's location is convenience of transporta-

tion. Already, there is bus service into the city every 20 min., with the trip taking about 30–40 min. In addition, arrangements have been made with Hertz "Driv-Ur-Self" service to keep cars on the field for use of transient pilots. Plans are also being considered for a "fly-it-yourself" service to enable pilots to rent aircraft.

Foreign Airport Trends

Abroad, the building of giant new air terminals is somewhat behind the development achieved in this country. One of the problems to be encountered is that, in addition to once again providing for the handling of former domestic and inter-continent traffic, facilities will have to be provided for the entry of U. S. airlines, as influenced by the Chicago decisions.

Thus far, the most advanced design appears to be that for Warsaw's new terminal. Total area is to comprise 2,535 acres and seven runways are planned. Two 245-ft. wide blind-flying runways are to be included—for landing, 9,150 ft.; for takeoff, 10.700-ft. Remaining runways will vary in length from 6,400 to 8,550 ft., with a width of 152 ft. It is estimated that this pattern will allow 180 plane movements per hr. Here too, we have the parallel runway system to expedite traffic.

Airport ground facilities, hangars, administration building, and loading platforms are to be sited in the center of the field, a practice now in vogue in the U. S. The seven-story administration building is to contain separate hotel accommodations for flight crews and passengers. An interesting feature of the loading platforms is that each is to be equipped with a turntable to facilitate plane handling.

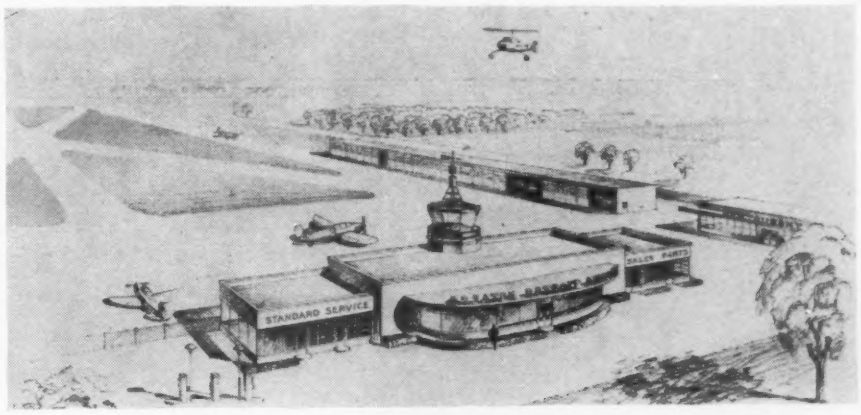
As now appears to be the custom in major airport construction, the Warsaw terminal is to be built in three stages—the first to include preparation of the site, installation of most of the drainage system, building an approach road from the main highway, construction of three main runways and three hangars, erection of one wing of the administration building, and construction of several maintenance shops.

Britain's official plans are not as yet very well known. However, an independent contest (sponsored by *The Aeroplane*) for the best design for a London airport, resulted in a number of interesting and well-considered entries. The proposal submitted by H. J. Coates, E. R. Morgan, and F. W. Smith took first prize and appears to most clearly indicate British thought on airport design.

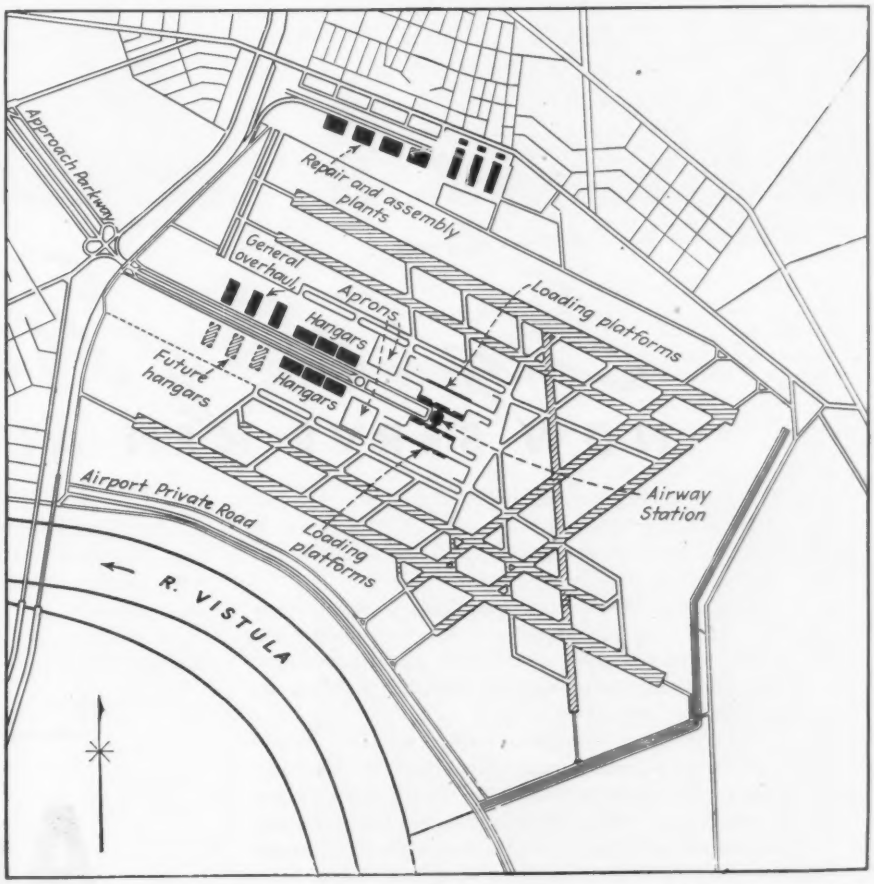
A combined landplane and flying boat terminal, this project calls for eight 10,000-ft. main runways, each of which could ultimately be extended to 15,000 ft. The parallel system would also be used, with strips laid out to hold taxiing to a minimum. The runways are designed to take craft weighing up to 200 tons, with static loads of 60 tons on each set of wheels. The runway numbering system would be to label one end of each to coincide with its proximity to the nearest 10 deg., omitting the last digit. For flying boats, a 15-ft.-deep artificial lake would have a primary landing channel about 18,000 ft. long.

A seven-story administration building would serve both types of craft. This structure would contain hotel accommodations comprising 52 double rooms, 44 singles, and 4 special suites. Two-story loading platforms with twelve loading points form an arc about the building. All refueling points would be strategically located underground.

A peak capacity of 24 planes hourly is anticipated, although expected movement is calculated at about 200 craft daily.



Being built for personal flyers by Detroit Aviation Corp., this pleasing layout gives some idea of plans underway for future lightplane owners. Building (foreground) is to contain service, sales, and parts facilities, also a display room for aircraft. Included will be a lounge for visitors.



New air terminal proposed for Warsaw, Poland, shows U.S. influence in design of runway pattern and building placement. Feature would be separate hotels for air crews and passengers. Special runways are planned for blind landings and takeoffs. (From "Warsaw Airport" by Aero Dept., Polish Ministry of Industry, Commerce, & Shipping, London)

Portrait of Randolph C. Walker by John Carlton

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PRESIDENT

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GLOBE CALCULATOR IS QUICK ON AVIGATION DATA

By LT. ROBERT A. BLEIER, *Air Corps*

Combining celestial and terrestrial spheres, realistic computor promptly determines great circle courses and distances, also speedily "puts finger" on pertinent directions, altitude and azimuth of stars, and local and world time.

JUDGED TO BE the most effective means yet devised for showing the comparative positions of the terrestrial and celestial globes, the new Hagner Universal Globe Calculator is designed and constructed so accurately that all problems of the astronomical triangle can be solved by inspection to a tolerance of approximately 33 min. of azimuth and 12 min. of altitude.

With this graphic device, one may quickly determine: Great circle course and distance between any points on the earth, including the distance and time of all points along the route; true north; altitude and azimuth of visible stars at any predetermined time and point, with a check on comparative positions of celestial and terrestrial objects along any course; and time of sunset and sunrise, time locally, also time anywhere on earth with a single setting. Accordingly, this computor is seen of decided value in avigation schools. Moreover, it will afford great aid to the pilot prior to an extended flight and it will particularly help the avigator in his pre-computation of essential data.

The Hagner globe consists of a 16-in. standard world sphere over which is superimposed, with clearance for rotation, a Plexiglas miniature of the celestial sphere. Positions of the 55 avigational stars listed in the air almanacs are accurately represented by luminous dots on the outer globe, with the names of the stars engraved. Movable circles and arcs for representing the astronomical triangle are provided, with these circles and arcs marked with scales for measuring (a) altitude, (b) latitude, (c) declination, and (d) azimuth. In addition there is the outer slide which gives the great circle distance between any two points on earth as well as the time needed to run at a predetermined airspeed. This slide is calibrated in both nautical and statute miles, and the time scale is in hours and minutes.

Instructions for Use

1. To secure great circle course and distance:
   (a) Set zenith lens over departure spot on earth. Lock globe.
   (b) Set lens on distance slide over destination.

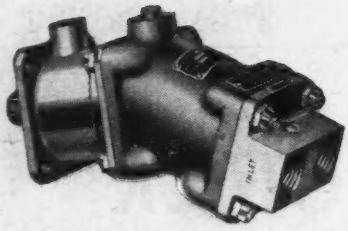
(*Turn to page* 248)

Details of Calculator are revealed in this closeup of special 6-in. globe used by Mr. Hagner. Only slightly less comprehensive in scale readings, this smaller sphere is essentially the same as standard 16-in. device.

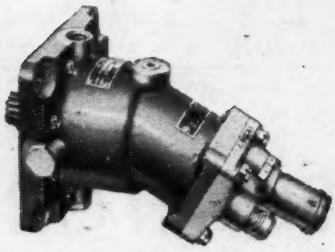
Inventor and Author Compare Figures

Mathematical Altitude (H.O. 214)	Calculator Altitude	Calculator Error	Mathematical Azimuth (H.O. 214)	Calculator Azimuth	Calculator Error
61° 08′	61° 20′	12	103.3	103	.3
32° 15′	32° 20′	5	146.3	146.6	.3
37° 46′	37° 40′	6	116.6	116.7	.1
31° 04′	31° 00′	4	105.9	106.6	.7
43° 37′	43° 32′	5	125.9	126.6	.7
42° 04′	42° 05′	1	110.3	109.7	.6
28° 05′	28° 10′	5	127.9	127.3	.6
36° 40′	37° 00′	20	142.1	141.8	.3
52° 57′	52° 50′	7	125.2	124.8	.4
30° 11′	30° 05′	6	99.3	98.9	.4
17° 41′	17° 55′	14	116.5	115.8	.7
29° 21′	30° 00′	39	163.8	163.2	.6
24° 39′	25° 05′	34	148.9	148.4	.5
57° 58′	58° 00′	2	117.7	116.8	.9
47° 01′	46° 40′	21	102.9	101.9	1.0
56° 28′	56° 17′	11	64.8	64.0	.8
		192			8.9
	Ave. Error	12′		Ave. Error	33′

To illustrate accuracy of avigation device, Inventor Fred Hagner rapidly works 16 selected astronomical-triangle problems by inspection of Calculator while Author Bleier provides a check by determining solutions mathematically. And as shown in accompanying tabulation of results, average error on graphic computor was only 12 min. in altitude and 33 min. in azimuth.



1000 PSI CONSTANT DELIVERY
PISTON TYPE PUMP



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PISTON TYPE
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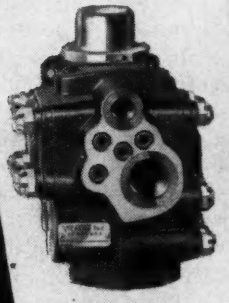
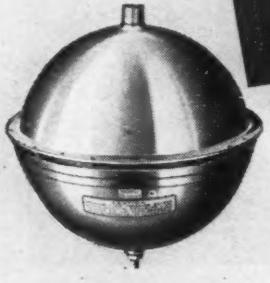
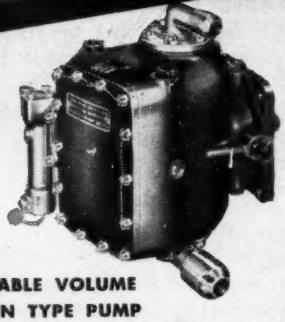


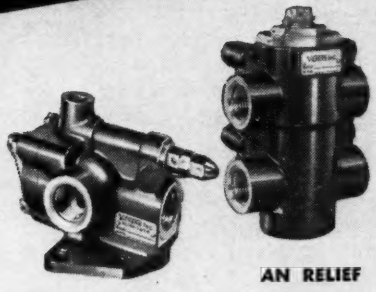
UNLOADING
VALVE



5", 7½" AND 10"
ACCUMULATORS

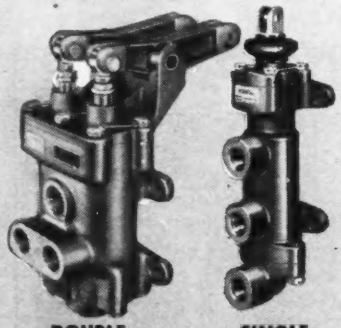


VARIABLE VOLUME
PISTON TYPE PUMP



RELIEF VALVE

AN RELIEF
VALVE



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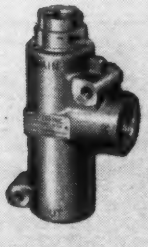

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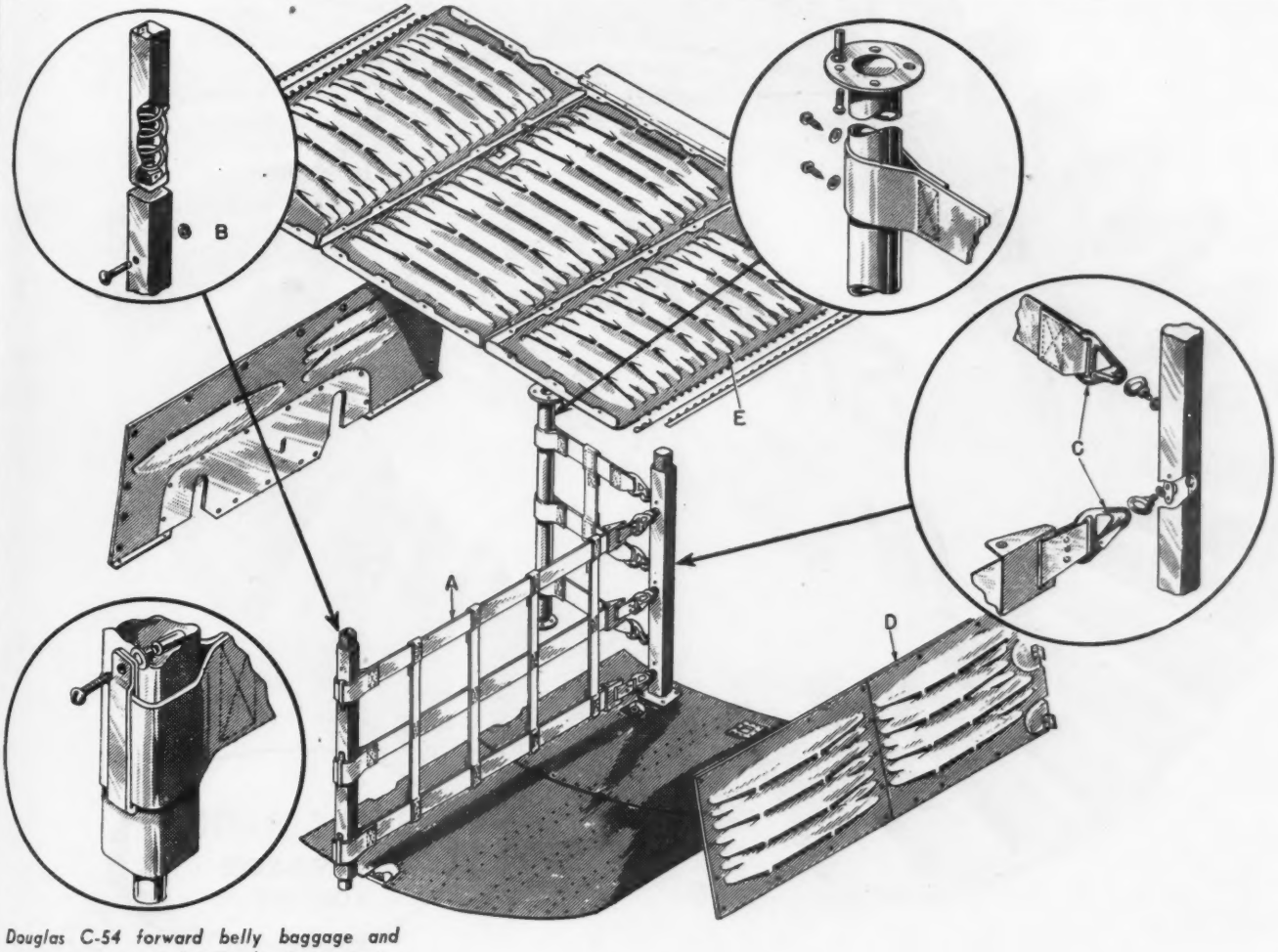
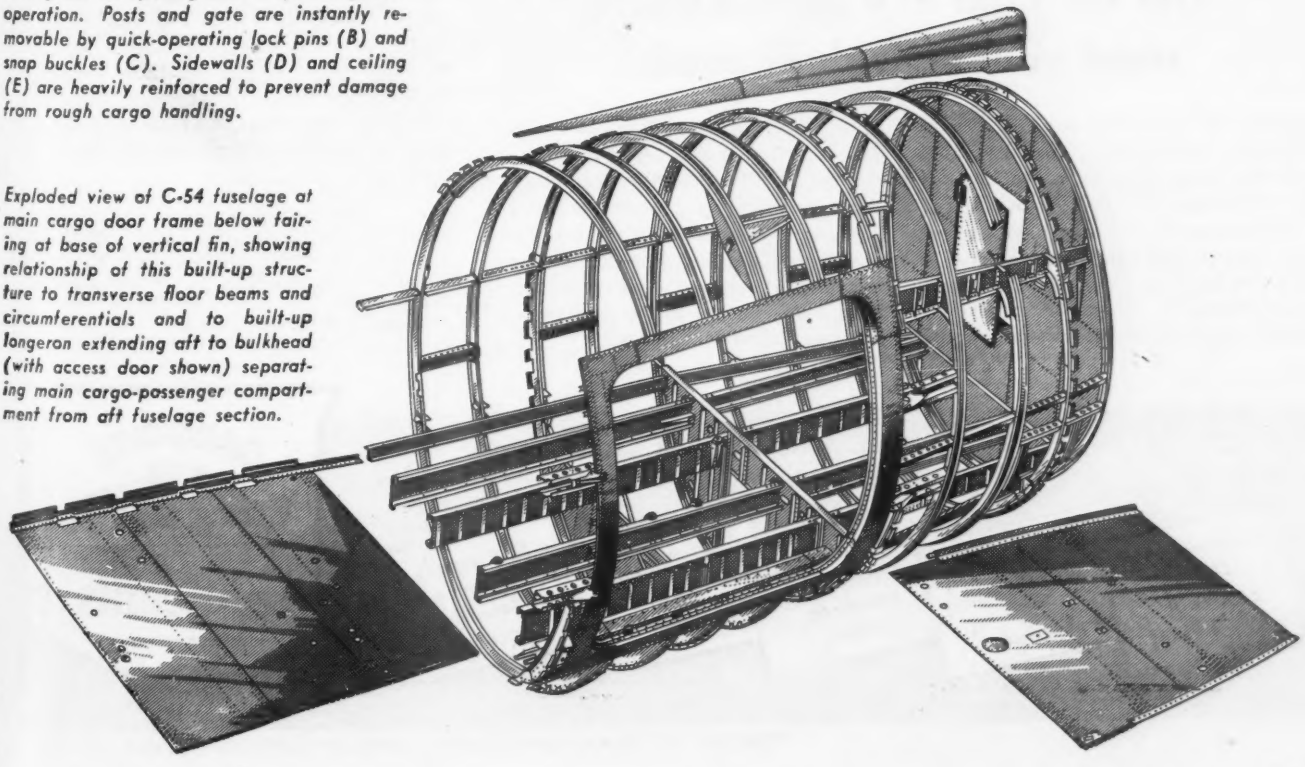


Douglas C-54 forward belly baggage and cargo compartment details, showing protector gate (A) to prevent baggage or cargo from falling out on opening door or jamming door operation. Posts and gate are instantly removable by quick-operating lock pins (B) and snap buckles (C). Sidewalls (D) and ceiling (E) are heavily reinforced to prevent damage from rough cargo handling.

Exploded view of C-54 fuselage at main cargo door frame below fairing at base of vertical fin, showing relationship of this built-up structure to transverse floor beams and circumferentials and to built-up longeron extending aft to bulkhead (with access door shown) separating main cargo-passenger compartment from aft fuselage section.



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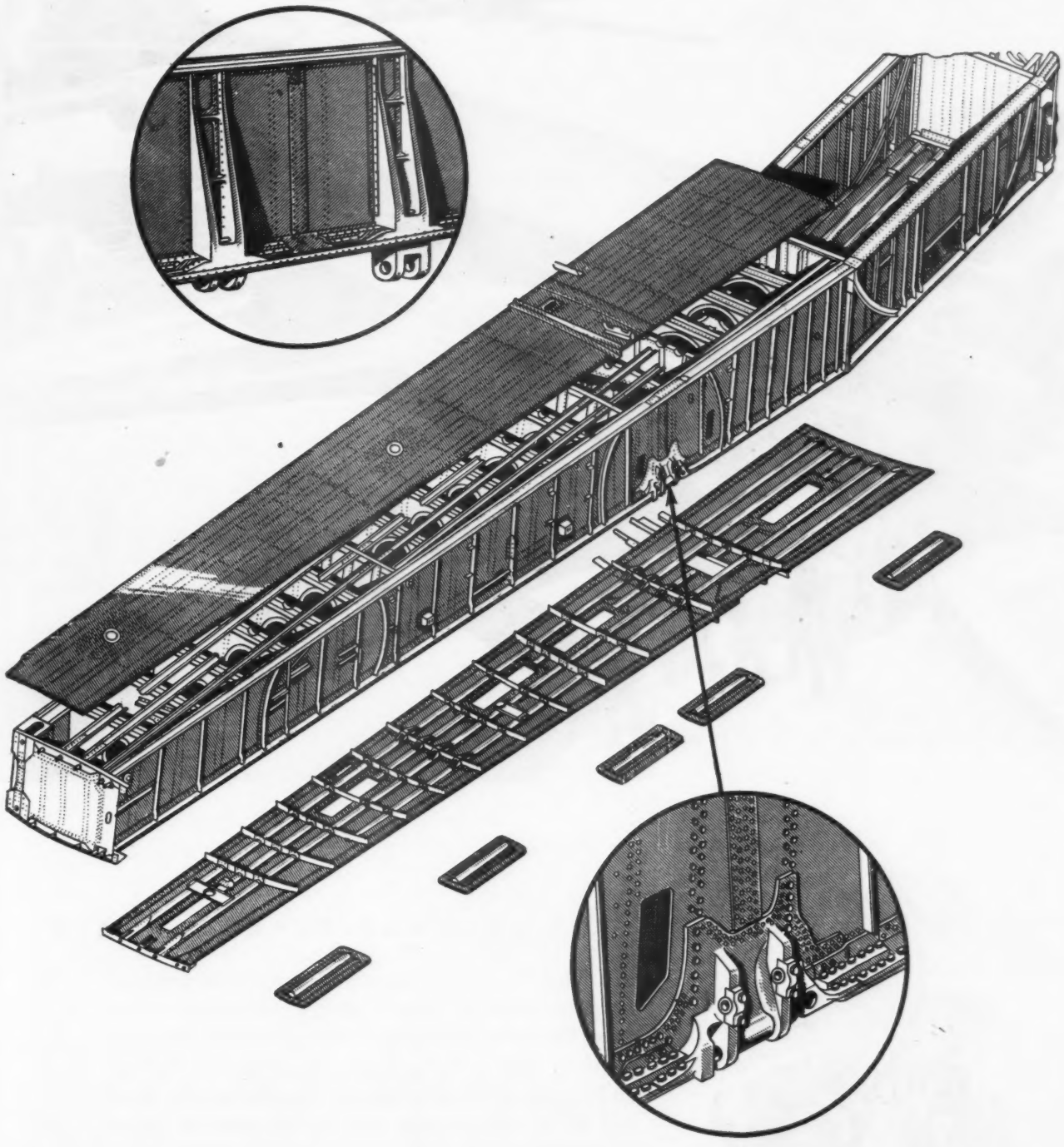
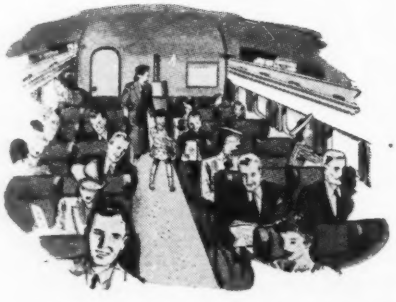


Center wing front section of Douglas C-54 between front and center spars, with lower skin removed to show stringers, stiffeners, and inspection plates. Front spar landing gear fitting is shown enlarged in circle at bottom right, while center spar landing gear fitting detail is circled at top left.

23 [illegible]estic Airlines and [illegible] Foreign Airlines Now [illegible]se Douglas Equipment.

War Tested FOR POSTWAR DEPENDABILITY



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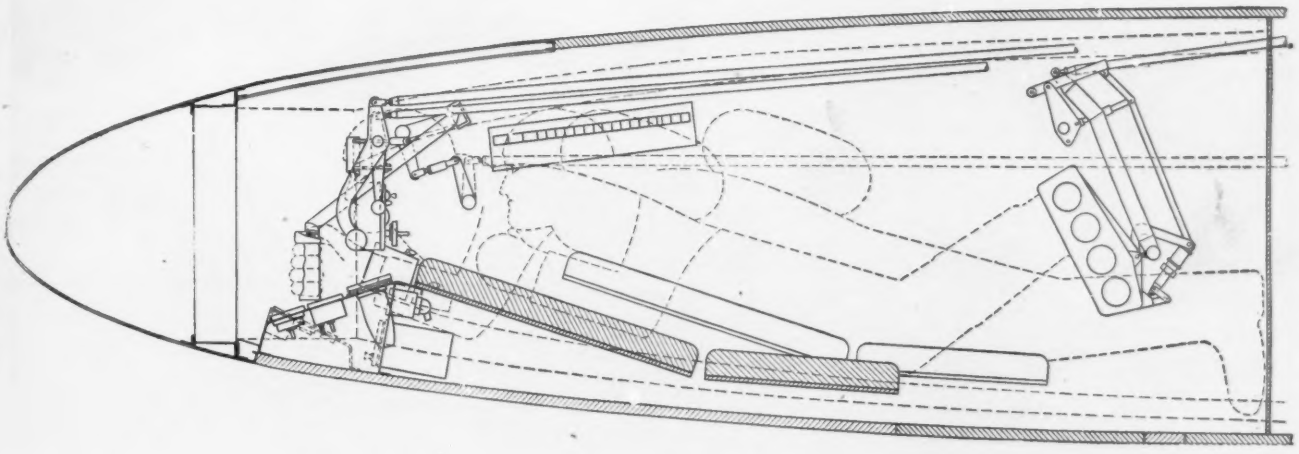

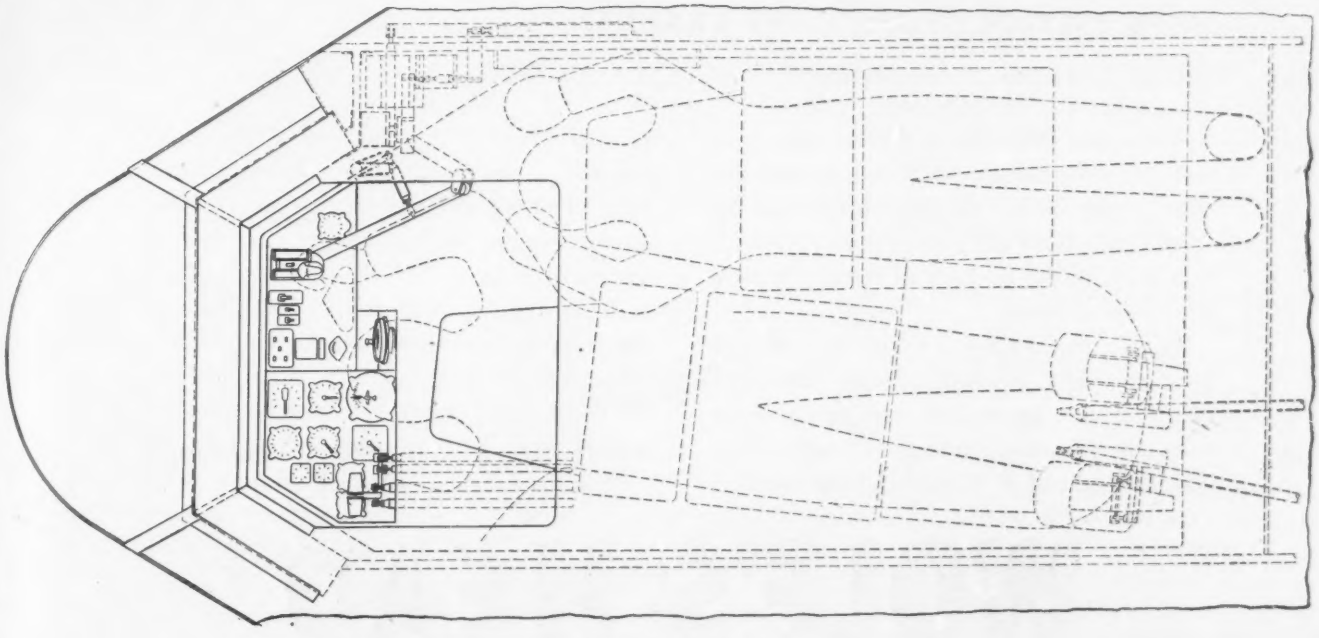

Cross section (above) and plan view (below) showing cockpit arrangement of German P-60A and B, proposed flying wing powered by two BMW 003 or Heinkel Hirth 011 jet engines. Craft has conventional controls, except that stick and rudder pedals are hanging type, and there is provided a control to separate tab control mechanism from stick. No rearward vision was provided, designers relying instead on speed of craft to make it unnecessary. (Additional details on P-60 were given in October AVIATION, page 172.)

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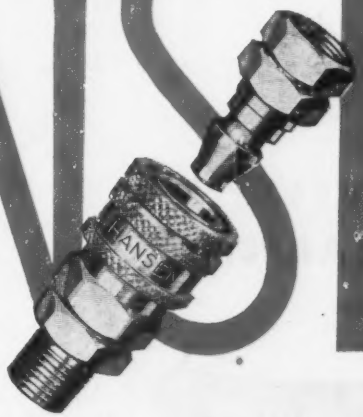

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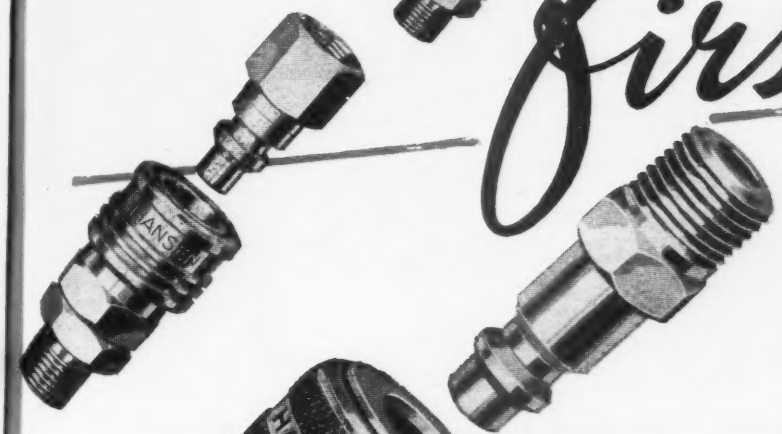

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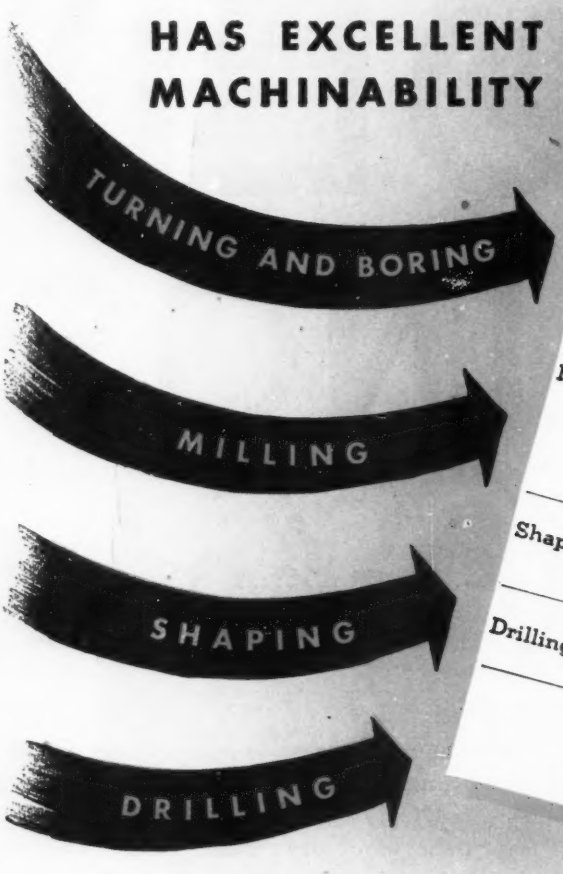

TABLE I
SPEEDS AND FEEDS RECOMMENDED FOR MACHINING MAGNESIUM ALLOYS

Type of Operation		Speed Feet/Minute	Feed In./Blade/ Revolution	Max. Depth of Cut, In.
Turning and Boring	Roughing	Up to 1000	.030—.100	.50
		1000—2000	.010—.045	.30
		2000—5000	.010—.030	.15
	Finishing	Up to 1000	.005—.025	.10
		1000—5000	.003—.015	.05
Milling	Roughing	Up to 1000	.005—.025	.50
		1000—2000	.005—.020	.30
		2000—5000	.005—.010	.15
	Finishing	Up to 1000	.005—.015	.07
		1000—5000	.003—.010	.05
Shaping	Roughing	Up to 150	Inch/Stroke Up to .25	.50
	Finishing	Up to 150	Up to .25	.25
Drilling	¼-in. dia.	100 and over	Inch/Revolution .005—.020 (1)	
	1-inch dia.	100 and over	.020—.050 (1)	

(1) Applies to hole depths up to five diameters. For longer holes, the recommended ranges are .004 to .008 for ¼-inch diameter, and .015 to .030 for 1-inch diameter.

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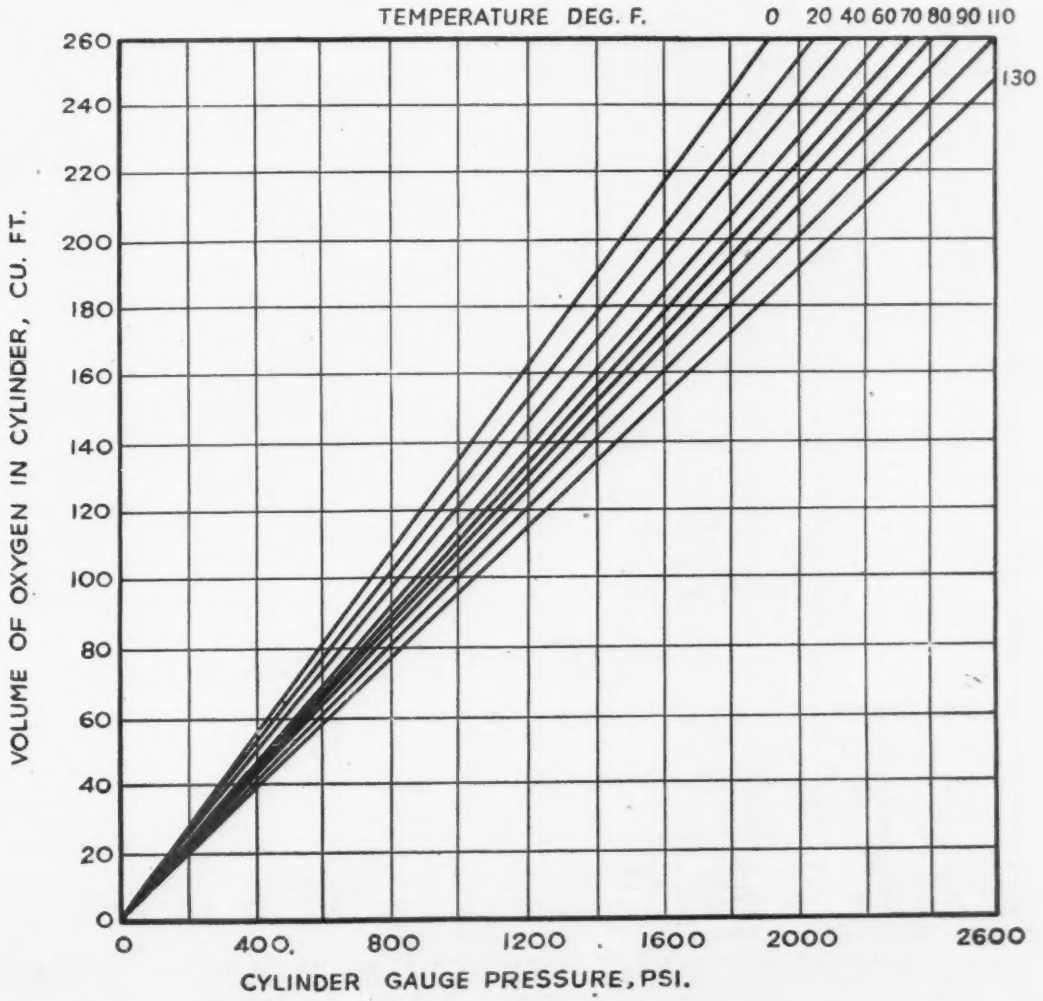
SHEET NUMBER . . . D-34
CLASSIFICATION . . Materials
SUB CLASSIFICATION . Oxygen

Estimating Oxygen Volume in Cylinder

Approximate volume of oxygen in a cylinder can be estimated by use of accompanying table. To use chart, locate point where vertical *cylinder gage pressure* line crosses diagonal *temperature* lines, then follow across horizontally to *volume* figure in lefthand column. For example: If cylinder pressure is 1,400 psi. and room temperature is 60 deg. F., approximate volume in cylinder is 160 cu.ft.

(Courtesy Linde Air Products Co.)



REVIEW OF PATENTS

By A. HARRY CROWELL
Registered Patent Lawyer

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

Anti-Torque Propeller is "aired" to minimize disturbing vibrations by provision of openings in side wall of fuselage tail to admit air to propeller in area of propeller disk which overlaps fuselage, thus assuring approximate uniform loading of entire disk. Drag of rotary wing system is utilized for feeding air to propeller in overlapping area.—2,383,038, filed June 4, 1943, pat. Aug. 21, '45, E. Bossi.

Rotary Wing Mounting is intended to permit tilting about center of rotation to change thrust angle and also allow simultaneous alteration of blade pitch angle so as to vary direction and intensity of thrust. Axis of lifting screw is encircled by tubular ring mounted on universal joint, with tubular hubs attached to outer perimeter of ring, blades being supported by hubs and a flexible steel cable threaded around ring and attached to blades to resist centrifugal force, means being incorporated to rotate ring through universal joint.—2,383,139, filed Aug. 12, '43, pat. Aug. 21, '45, C. E. McGuire.

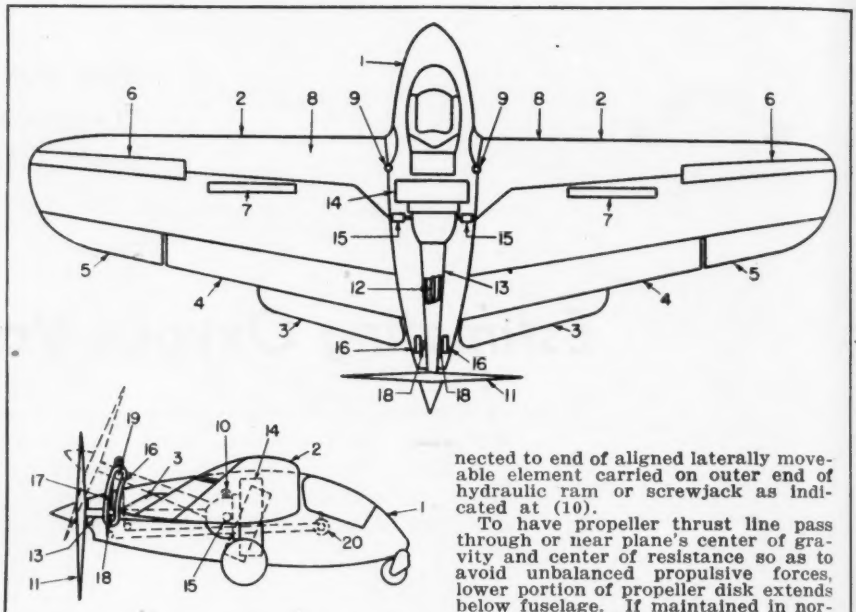
Adjustable Seat is particularly adaptable for use by bombardier, permitting ready adjustment with reference to bomb sights and also to more comfortable normal resting position. Resilient lifting means is concealed in seat struts, latter being connected to sliding mounting element for fore-and-aft pivotal adjustment.—2,383,173, filed Oct. 29, '42, pat. Aug. 21, '45, M. Watter, assignor to Edward G. Budd Mfg. Co.

Static Test Apparatus for aircraft structures is designed to so nearly simulate loading under actual flight conditions that yield point and ultimate strength can be predicted from test stress-strain and deflection data, thus permitting use of plane rather than model, without injury to plane. Lifting patch, applied over plate joints, rivets, and curved surfaces, to develop lifting force or negative pressure, is capable of transmitting pulling force of large magnitude while offering negligible resistance to buckling of tested member in event of sufficient flexure to cause buckling.—2,383,491, filed Sept. 11, '39, pat. Aug. 28, '45, P. H. Kemmer and E. R. Weaver.

Airplane Heater, designed to provide increase in heating capacity and simplify regulation and control, has fan-driving air motor actuated by airflow along path extending from scoop or ram inlet opening in skin of plane to outlet opening, with inlet and outlet so disposed that pressure in former substantially exceeds that in latter. Air motor preferably comprises wheel formed with curved channels which, extending outward from central air-receiving portion of wheel, discharge air received at wheel periphery.—2,383,650, filed Mar. 30, '43, pat. Aug. '45, F. O. Hess, assignor to Selas Corp. of America.

Helicopter Design includes lifting rotor with blades inclinable about longitudinally extending axes, inclination control, inclinable rotating inertia means associated with rotor and control, and linkage interrelating inclination of inertia means, blades, and control. In operation, inertia means maintains itself relatively non-inclined in space as fuselage undergoes

(*Turn to page* 257)



Tailless Airplane of pusher type incorporates means for elevating propeller without disrupting driving connection between it and engine or materially disturbing relationship between propeller thrust line and craft's center of gravity. Attitude of propelling means can be changed from ground maneuvering position to flight attitude, or vice versa. As seen in accompanying illustration showing plan and elevation of craft, fuselage (1) is comparatively short streamlined body overlapped for greater portion by root chord length of wing (2). Angle of attack is controlled by elevators (3) in form of movable flaps hinged to trailing edges of wing flaps (4), and lateral control is effected by ailerons (5) hinged to tip portions of wing rearward edges. Arrangement of elevators and forward inclination of wing rear edges places ailerons considerable distance ahead of elevators and sufficiently near axis of wing center of lift, so that aileron operation to change banking attitude does not materially affect pitching stability. Also, elevators are sufficiently behind center of lift axis so that control of angle of attack is sufficiently sensitive. Wings may be provided with controllable lift-increasing slots (6) and spoilers (7) to give guide control. Wing rigid portion (8) is pivotally connected to fuselage by substantially vertical pivot, (9) and at rearward inner corner it is also connected to end of aligned laterally moveable element carried on outer end of hydraulic ram or screwjack as indicated at (10).

To have propeller thrust line pass through or near plane's center of gravity and center of resistance so as to avoid unbalanced propulsive forces, lower portion of propeller disk extends below fuselage. If maintained in normal flight position, propeller might strike ground during landing and take-off, and to place propeller in proper position for flight, while avoiding danger of propeller striking ground, power plant is pivotally mounted so that propeller can be tilted upward from flight position (shown in solid representation of elevational view).

Propeller (11) is mounted at end of drive shaft (12) extending rearwardly through supporting tube (13) from engine (14). For tilting movement, pivotal mounts (15) are on line passing through or near power plant center of gravity. Distance of propeller from engine is such that upward inclination not exceeding 30 deg. brings lower edge of propeller disk above fuselage bottom, or at least to position for propeller to safely clear ground. Provided for tilting power plant about axis of pivotal support (15) are pair of arcuate guides (16), rigidly secured at lower portion of fuselage, and cable (17) extending over pulleys at each end of guide member and connected to one of two guide pins (18) extending from tube (13) into elongated curve slot (19) in guide member. Cable is guided to cockpit and connected to manual actuating device (20). Pair of cables may be disposed one at each side of tube (13) and associated respectively with parallel guide members (16).—2,384,296, filed Mar. 12, '42, pat. Sept. 4, '45, M. E. Gluhareff, assignor to United Aircraft Corp.

Recent Books

URANIUM AND ATOMIC POWER, by Jack De Ment and H. C. Dake. Chemical Pub. Co., Brooklyn, N. Y. 343 pages, tables, appendices. $4.

Presented here are the underlying principles and theories pertinent to an understanding of atomic power and the atomic bomb. Two chapters are devoted to the occurrence and properties of uranium minerals and two others to their qualitative and quantitative analysis. Remaining chapters discuss the chemistry and physics of uranium and specific methods in uranometry.

FUNDAMENTALS OF MECHANICAL INSPECTION, by Rolland Jenkins. McGraw-Hill Book Co., New York City. 179 pages, photos, drawings, index. $1.75.

Addressed to trainees and junior inspectors, this handbook covers the how and why of inspection. After a review of the purpose and function of inspection, the principles and use of fine tools and precision instruments are discussed and explained.

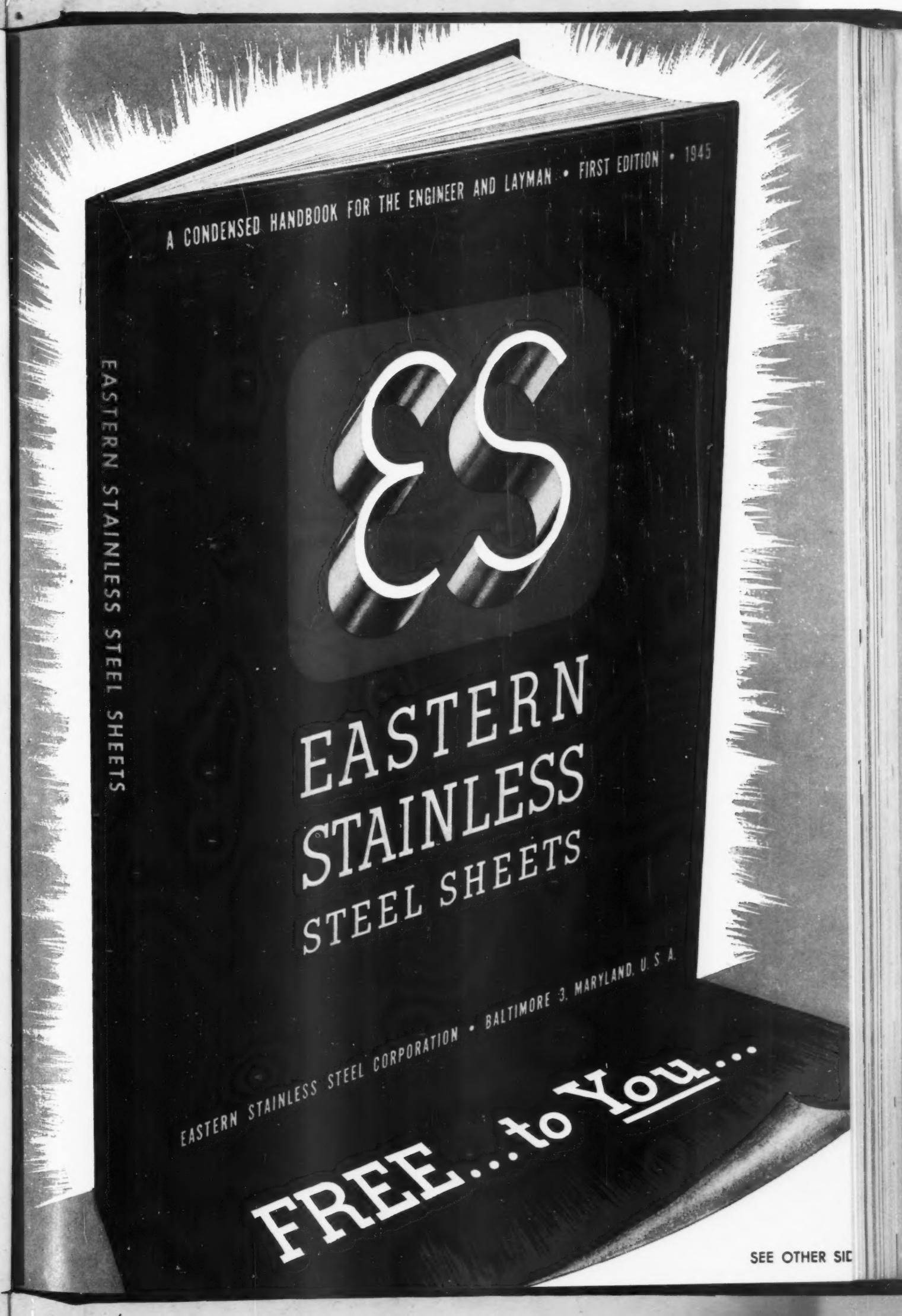
ATOMIC ENERGY FOR MILITARY PURPOSES, by Henry D. Smyth. Princeton University Press, N. J. 264 pages, photos, appendices, index. $1.25.

The full text of the official report on development of the atomic bomb by the U. S. Government, with the addition of photographs and a later government release on the initial New Mexico test of July 16, 1945.

PRIVATE PILOT EXAMINATION, by Charles A. Zweng. Pan American Navigation Service, North Hollywood, Calif. 34 pages. $1.

A new manual designed to prepare the private pilot for the new written examination. Material comprises Part 60, Air Traffic Rules and Part 43, General Operation Rules, with multiple choice questions covering these regulations. A com-

(*Turn to page* 258)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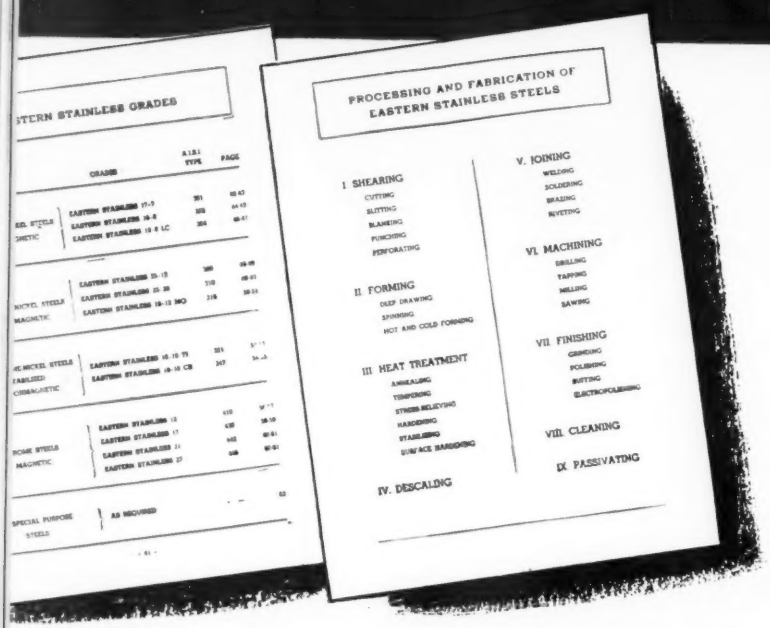

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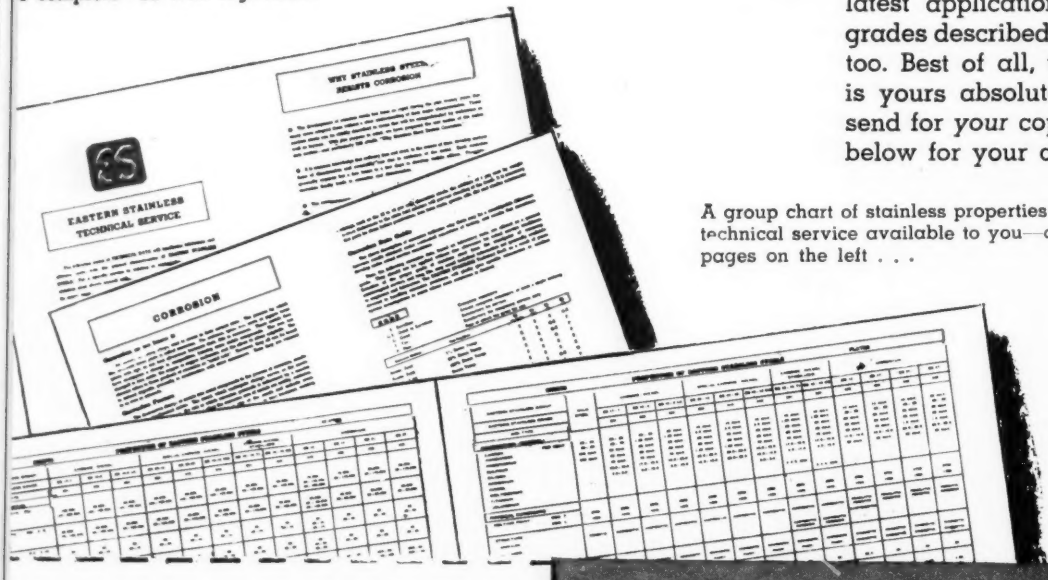

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THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. BULMAN, New York

Senate Passes State-Agency Airport Bill; Municipalities May Get Nod in House Action

. . . Details of "prox" fuse revealed . . . Truman for atom authority . . . House committee proposes Navy with 116 flat-tops . . . CAB weighs applications for mid-country lines . . . Problem of radio ranges tackled . . . Ask resumption of CPT.

The month saw the Senate pass its version of the long-pending national airport program, providing $75,000,000 per year for 5 yr., to be administered by CAA, the funds to channel through state aviation agencies rather than local governments. The bill, S-2, was introduced by Sen. Pat McCarran.

In the House, which has long battled over the airport bill and other bills which would revise civil air law, early action is expected on HR-3615, sponsored by Rep. Clarence Lea, which provides $65,000,000 a year for 10 yr. Previous tests have shown that the House is favorable to the program.

Lea's measure can be amended on the House floor toward conformity with the McCarran bill. Undoubtedly the proposed appropriation will be raised to match the McCarran figure; some House members want to raise it to $100,000,000, as originally suggested by CAA.

State aviation officials won state disposition of funds in the Senate measure, but municipalities will have the advantage in the House, and cities and local governments may win the right to sponsor airport projects drawing federal aid.

The President, in his recent message to Congress, gave his support to airport development and helped to speed the legislation. Several pleas on the Senate floor for economy, and references to the comparatively small portion of the public served by aviation, resulted in cutting the McCarran proposal from $100 billion to 75.

A bill has been introduced in the Senate providing control of disposal of Army and Navy surplus airports. Some of such fields will be useful to municipalities and to private aviation enterprises.

Details of "Prox" Fuse Revealed by Navy

Facts have been released by the Navy on the "proximity fuse" which enabled gunners to destroy up to 79% of targets attacked, and which is authoritatively rated as second only to the A-bomb in importance among war developments.

Basically, the fuse is a radio transmitter-radar set no bigger than a pint bottle, having tubes ⅝ by ⅛ in., installed in the nose of gun projectiles. When the shell is within 70 ft. or so of an object, such as an airplane, a ship, or the ground, radio emanations from the set reflect back and by relay trip a switch which detonates the charge.

Authorities have stated recently that this miniature radio design will be valuable in the development of many automatic devices for the control of industrial mechanical processes, and small radios.

In combat, the fuse eliminated conventional fuse setting and excluded errors inherent in fuse mechanisms. Devastating results looked to the enemy like uncanny accuracy of aim. The device played a major part in several important victories, especially in the British defense against guided missiles. It appears not to have been used in airborne guns.

Adm. Ernest J. King said it contributed greatly in winning the war. The late Capt. S. R. Shumaker, as director of research and development in Navy's Bureau of Ordnance, began its production. Research facilities were provided by Carnegie Institution of Washington and Johns Hopkins University of Baltimore. Dr. Merle A. Tuve, of the National Defense Research Committee, headed the program.

Crosley Corp., Sylvania Electric Products, Radio Corp., Eastman Kodak, and McQuay-Norris carried out assembly operations, which reached 40,000 per day, while the cost was reduced from $40 to $18 each. Expenditures on the project totaled $800,000,000 and 80,000 persons, 85% women, were employed on it.

Truman for Atom Authority; To Test-Atomize Nagato?

President Truman, having recommended to Congress that a commission be established to control continued development of atomic energy, revealed that he is firmly opposed to dissemination of bomb secrets among other nations at this time, but he proposes to confer with England and Canada, to whom the data is available, and later with other powers, with a view to a world ban on the use of atomic weapons.

The President wants the Government to continue operation of atom plants in Washington State and Tennessee, which are believed to be still producing bombs. Guesses as to the number of A-bombs now on hand run from 10 to 100. Newer bombs are said to have many times the power of those dropped on Japan.

The Navy mooted test of effect of atomic bombs on combat vessels by using the captive Jap battleship Nagato as a target. This warship withstood attack by 500 naval aircraft during the war.

TOUGHEST CAT YET

Grumman F8F Bearcat, though some 3,000 lb. lighter than predecessor F6F Hellcat, is just as powerful with P & W 2-100-hp. engine—delivering up to 2,800 hp. with water injection—and four blade Aeroproducts prop. Sea level speed is over 400 mph., rate of climb is better than 5,000 fpm., and extreme range under ferrying conditions is 1,500 mi. Armament consists of four 50-cal. machine guns plus rockets and bombs. (British Combine photo)

House Committee Proposes Navy With 116 Flat-Tops

A navy including 116 aircraft carriers among a total of 1,079 ships has been proposed by the House Committee

COMING UP

Nov. 1: SAE Southern California Section Aeronautic Meeting, Hotel Biltmore, Los Angeles.
Nov. 5 - 7: National Assn. of State Aviation Officials Annual Meeting, Coronado Hotel, St. Louis.
Nov. 6 - 7: SAE National Fuels & Lubricants Meeting, Mayo Hotel, Tulsa.
Nov. 15 - 16: First Statewide Arizona Aviation Conference, Pioneer Hotel, Tucson.
Nov. 17: National Aeronautical Assn. Board of Directors' Fourth Quarterly Meeting, Oklahoma City.
Nov. 19: Air Industries & Transport Assn. of Canada, Annual Meeting, Montebello.
Nov. 19 - 20: National Aircraft Standards Committee, AIA, Tenth Annual Meeting, Chicago. (Executive Board Pre-Meeting Conference, Nov. 15-16)
Nov. 19-21: Third National Aviation Clinic, Oklahoma City.
Nov. 26 - 27: National Aeronautic Assn. Joint Private Flyers' Conference, Statler Hotel, Washington, D. C.
Nov. 26-30: ASME 66th Annual Meeting, Hotel Pennsylvania, N. Y. C.
Dec. 3 - 5: SAE National Air Transport Engineering Meeting, Edgewater Beach Hotel, Chicago.
Dec. 10-11: ADMA Meeting, Hotel Statler, Cleveland.
Dec. 13 - 14: Airline Finance & Accountant Conference, Dallas.
Dec. 16 - 17: International Aviation Day, El Paso.
Dec. 17: IAS Wright Brothers Lecture, Washington, D. C.
Dec. 17: Award of Collier Trophy, auspices NAA. (Place to be announced.)
Jan. 4 - 6, 1946: All-American Air Maneuvers, Florida Air Races, Miami.
Jan. 7 - 11: SAE Annual Meeting & Engineering Display, Book-Cadillac Hotel, Detroit.
Jan. 11 - 12: Cleveland Aircraft Show, Public Auditorium, Cleveland.

on Naval Affairs. This sea power would be only 220 ships less than the present VJ strength, which is the greatest in history. The U. S. had only 7 carriers when the Japs attacked.

The Committee's resolution suggests division of the proposed fleet three ways: One-third manned and ready to shoot; one-third tied up in paint and oil but ready to go; the remaining third decommissioned. The resolution is merely an expression of opinion; it has not yet been submitted for House vote.

There would be three 45,000-ton Midway class carriers; 24 Essex class of 27,000 tons (actually over 30,000); 10 light carriers of 11,000 tons; and 79 escort carriers.

Cost would be $2.5 to $4 billion per year. Midway and Essex carriers ship around 100 airplanes each; others down to a half dozen and less.

All proposals of military establishments and equipment are tentative pending determination of high policy on the future trend—whether toward more war or peace.

CAB Weighs Applications For Mid-Country Lines

CAB's Indianapolis hearings, in progress at this writing, concern applications for airline services reaching 800 towns and cities in Indiana, Ohio, Illinois, Michigan, Missouri, Tennessee, West Virginia, and Pennsylvania. It is not expected, however, that findings will result for at least six months. The considerations include feederlines and intercity helicopter services.

It is believed that increasing pressure from localities for aviation connections will cause CAB to liberalize its policy on shortlines. In the past, both the Board and the Post Office have said that only such routes which could earn their upkeep should be authorized. It is argued in Congress that branch services should be established and that they will soon generate non-apparent traffic which will support them.

Problem of Radio Ranges Tackled by NS Body

The Non-Scheduled Flying Advisory Committee was slated at this writing, to meet to discuss provisions of the CAB examiners' recommendations.

Of major interest were proposals for high frequency radio ranges throughout the country and arrangements for private flyers to use them. One problem is the crowded radio spectrum. Besides the call for aviation radio facilities, hundreds of demands for frequencies are coming in from railroads, shipping, police, news broadcasting, and other agencies. Production of simple, inexpensive airborne radio equipment is still another question.

The Committee will consider demands for modifications favoring air taxi and charter services, and for simplification of rules on aircraft mechanics.

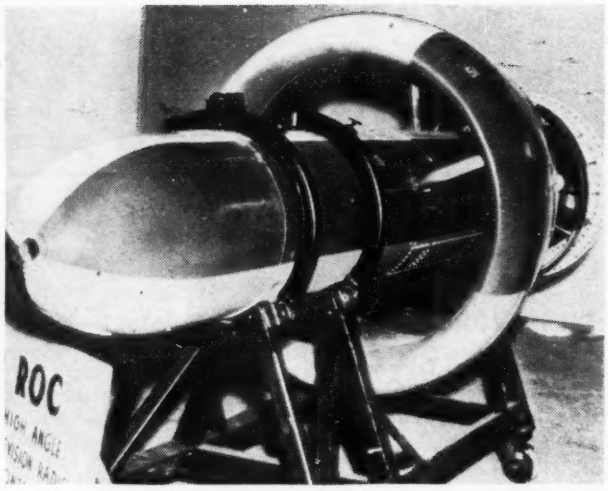
Ask Resumption of CPT

Re-instatement of the Civil Pilot Training program during the first half of next year is sought by CAA in a proposal to the Bureau of the Budget for $3,250,000 for training 15,000 new pilots in educational institutions. CPT authorization is still in effect, but funds for its re-activation must be provided by Congress. The program would be on about the same plan as before the war. The government would furnish about 75% of the cost, students the other 25%. One objection in Congress will be that thousands of ex-service pilots soon will be jobless.

License-Test Authority Granted Instructors

CAA has authorized flight instructors to give written examinations to applicants for licenses. The examination, given prior to first cross-country flight, is given on Parts 43 and 60 of CAR, dealing with rules of aircraft operation and traffic. Of the multiple-choice type, questions are carefully guarded against advance knowledge of trainees.

Flight instructors are now eligible to act as Private Pilot Flight Examiners, to give the flight test for certification. Instructors may be designated as examiners by CAA field inspectors; final designation must come from Washington. Examiners are being appointed to take part of the load off CAA inspectors, who have been giving all flight tests. Flight examiners are permitted to charge a fee of $5.



SEEING-EYE BOMB

AAF calls it ROC, a high-angle television raido-guided bomb. Controlled by plane or land station, it can be "put on" target through television eye in nose. ROC was one of many weapons taken off secrecy list at ATSC headquarters, Wright Field, where Air Force does much of its experimental and development work. (Press Assn. photo)

★ SPOT CHECKING ★

To test whether aerial deliveries of lobsters could be put on a successful commercial basis was project in a four-day experimental glider pickup operation tried out by All American Aviation between Rockland, Me., and N. Y. C. for Jordan Lobster Co. Wasp-powered Stinson was used in conjunction with a Schweizer TG-3A glider.

Soaring Society of America recently held first postwar motorless flight conference at Polytechnic Institute of Brooklyn, with topics including structural refinements, aerodynamic progress, air transport problems, instruction methods, and results of pure research.

First orders for Republic RC-2 Rainbow transport (page 174, Oct. **Aviation**) have been placed by PAA, with delivery of first six craft expected to start within 22 mo. Completely equipped, planes will cost about $1,250,000 each.

That vast majority of U. S. public not only wants postwar national air security but is also willing to pay extra taxes for it is shown in a survey of public opinion published by AIA. Also noted was fact that American public holds that U. S. makes best airplanes, with only 3 percent for Germany, 2 percent for England, 1 percent for Russia, and 3 percent with no opinion. Fully 81 percent believe that airports benefit communities they serve.

Half million AAF veterans will seek postwar jobs in aviation, according to CAA. Questioning 1,278 officers and 2,215 enlisted men, agency worked out percentage in relation to total AAF personnel. Some 62,000 officers want to remain in service, but no enlisted men in this group expressed such a desire. Some 87,000 intend to buy personal planes. A detailed analysis of study has been prepared for distribution by CAA's Office of Information.

N. Y. C. is planning construction of two personal airports, one in north Bronx and other in Staten Island. Former would be a Class 2 field and latter Class 3. Both will be about 500 acres in size and have cross-directional runways.

CAA estimates that cost of getting an airline route application processed is $25,000.

A special camera for photographing radar images has been developed by Fairchild Camera & Instrument Corp. Fully automatic, camera permits operator to preview image. Company states that device will be of value in providing radar maps of world-wide airline routes and as an aid in determining safe avigational and navigational paths.

First flight across Atlantic by a squadron of six blimps took place in June, 1944, when craft were ferried to Mediterranean to aid in anti-sub patrols. Nonstop flights up to 1,900 mi. have been accomplished by these craft.

Gifts totaling $500,000 for establishing a gas turbine laboratory have been received at MIT for graduate instruction and fundamental research.

Publications: The Stinson Story of Aircraft Progress is a booklet published by Stinson Div. of Convair telling of company's progress since 1925. . . . Story of PAA personnel liberated from Jap internment camps is vividly set forth in Pacific-Alaska's Div.'s illustrated booklet, **Return from Hell.** . . . Route maps of all airlines entering N. Y. C., with story of their growth and future plans, is given in **Your Airlines,** which may be had for 10c. per copy by writing Brooklyn Eagle Resort & Travel Bureau, **Brooklyn Eagle,** Brooklyn 1, N. Y. . . . "Biennial Report of the Chief of Staff of the U. S. Army to the Secretary of War" is Gen. Marshall's 122-page handsomely illustrated detailed review of war from July 1, 1943, through June 30, 1945, covering operations by all forces and Allies in all theaters.

New fighter craft tested by AAF include Tucker XP-57, Grumman XP-65, Vultee XP-68, Republic XP-69, Curtiss XP-71, Bell XP-76, and NAA XP-78. New attack-bomber types are NAA XA-27 with two 1,000-hp. Wright Cyclones, Douglas XA-33, Howard Hughes XA-37, Beech XA-38, Fleetwing XA-39, and Curtiss XA-40.

University of Illinois dedicated 772-acre airport, which will be used for education and research, commercial service, personal flying, and military training. Stated to be larger than Chicago Municipal Airport, its three paved runways are 150 ft. wide and 5,300 ft. long. Primary objective is to implement school's program of research and education in aeronautics and air transport.

Cornell has established Graduate School of Aero Engineering, with project to include airplane landing strip, combined hangar and engine laboratory, and with a surplus warplane, several engines, and parts already available for teaching. Eventually, an aerodynamics and engine laboratory and flight research facilities will be located at proposed new Ithaca airport on East Hill, about 3 mi. northeast of campus.

ATSC has released facts on much-gossiped "Brodie-system" used to land and take off lightplanes from a steel cable, rigged with a Y at each end and suspended from four 85 ft. tubular plywood masts. Craft hangs by

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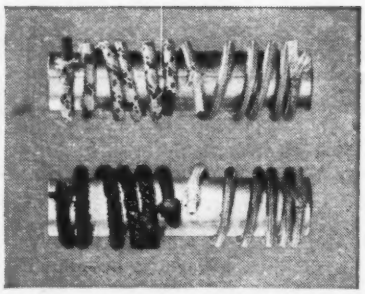
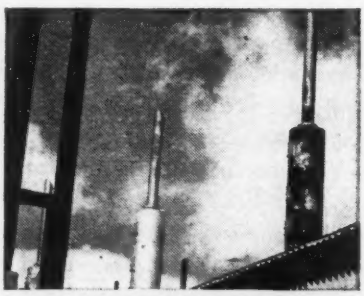


Cable insulated with Dow Corning Silicone rubber (at right) shows no change after one hour at 250° C., in contrast with organic rubber, which has melted and exuded freely through the braid.



The excellent condition of the stack at left, protected with silicone based paint, indicates the ability of such finishes to withstand moisture, oxidation, ultra-violet rays and temperatures up to 500°F.

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Inquiries are invited.

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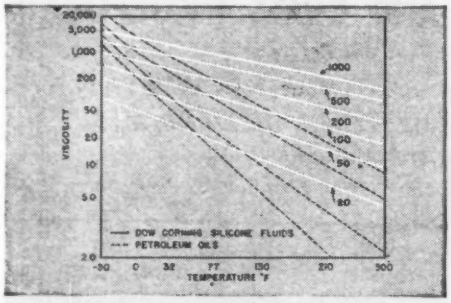

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FIRST IN SILICONES

a hook from landing slings on cable. Pilot releases tackle when flying speed has been attained. After hooking on for landing, plane is stopped quickly by friction. Entire apparatus is carried in one medium truck and can be set up in 24 hr. using hand tools. It was extensively used where construction of flight strips was impractical or unjustified.

CAA has assigned Fred H. Grieme, chief of airport section of technical div., and one other person not yet named, to Gen. Eisenhower's hq. to assist in restoration of aviation facilities in Germany and Austria for use by two or all three U. S. trans-Atlantic airlines, which are expected to extend soon into these countries. These men will serve under Maj. Gen. Robert Harper, head of Air Div. of Group Control, who discussed problems with CAA Administrator T. P. Wright.

★ CALLING NAMES ★

Dr. Theodore P. Wright, CAA Administrator, has been selected as winner of '46 Daniel Guggenheim Medal for "Outstanding contributions to development of civil and military aircraft, and for notable achievement in assuring success of our wartime aircraft production program."

William L. Wilson, Kellett v.-p., has been elected new chairman chairman of public relations advisory committee, eastern region, AIA. **Philip Hartman** is new mgr. of Aircraft Manufacturers Council's N. Y. C. office.

Alvin P. Adams has resigned from Fairchild to devote full time to his West Coast interests. Alvin P. Adams & Associates will serve as west coast rep. of company's various activities. Connected will be **William C. Rockefeller, A. A. Boon Hartsinck,** and **Moschelle Howard.**

George W. Pfeil, publisher, of McGraw-Hill's transportation magazine div., announces appointment of **Robert W. Martin,** formerly with Aeronautical Digest Pub. Co., as sales mgr. for *Aviation News* and sales rep. for AVIATION, *Aviation News,* and *Air Transport* in New England territory and metropolitan N. Y. **Andrew B. Martin** continues as sales mgr. of AVIATION and *Air Transport,* and in addition will be sales rep. for all three publications in N. Y. **Douglass A. Andrews** is new eastern district mgr. of AVIATION, *Aviation News,* and *Air Transport,* with hq. in Phila. He was formerly rep. for Aeronautical Digest Pub. Co. in that city.

TWA appointments: Richard C. Higgins is new asst. to v.-p.-traffic; **Dr. John H. Furbay,** is to direct newly-created Air-Age Education program; and **Leo R. Gilleran** has been named asst. to treas.

Mundy I. Peale has been recalled to Republic's home office to become v.-p. in charge of all sales.

D. B. Martin has been appointed N. Y. representative for Boeing, with hq. at 30 Rockefeller Plaza.

Eugene S. Bardwell is new director of public relations for Schweizer Aircraft Corp., glider maker.

Scott Aviation appointments: New sales staff personnel include **Gus Sada, Bill Zepp, Harvey Crane, Bill Gilmour, Bill Eckman, Jerry Gleason,** and **John Greene.**

Ted Ning and **Jerry Martin** have joined Fairchild to assist in C-82 Packet sales promotion.

Jack T. Dalton has been named mgr. of distribution for Bendix Radio Div., and **W. H. Autenreith** is new eastern district mgr. for N. Y. territory.

J. Lederer, chief engineer, engineering dept., Aero Insurance Underwriters, has been named areo engineering consultant to Aviation Section, N. Y. Board of Trade.

Northrop appointments: **Robert Biron** is new v.-p. of industrial relations; **Theodore C. Coleman** resigned as v.-p., but will continue as a director; and **R. J. Pagen** is now treas.

John W. Waugh has joined sales dept. of Aeromatic Propellers.

C-W appointments: **Burdette S. Wright** will move from Buffalo to company's hq. in N. Y. C. to assist in reconversion; **W. G. Lundquist** has been named Wright Aero's chief engineer; and **Lou R. Crandall** has been elected to C-W's board.

John A. Smith has been appointed cargo sales mgr. for CAL; **John E. Cook** was made general traffic mgr.; and **Gerald S. Kitchen** was named to new post of cargo traffic rep.

Jessie L. Bathgate is new supervisor of stewardess training for WAL.

Capt. James Lund and **C. P. Collins** have been added to Con-

(*Turn to page* 215)

★ CANADIAN NOTES ★

By James Montagnes

TCA notes: It's stated that well over half of TCA's transport revenue now comes from passenger traffic income, which climbed from 35 percent of total in '40 to almost 55 percent in first half of '45. . . . To aid transocean service, company now has liaison officer at London for close contact with Canadian High Commissioner and facilitation of passenger priorities on converted Lancasters operating between Montreal and Prestwick. . . . To supplement trans-Atlantic services and planned routes to Australia, New Zealand, West Indies, and South America, TCA intends to span North Pacific to Russia and China, using Canadian-built Douglas DC-4Ms. Meanwhile, company has received its first DC-3, seven more have been ordered from Douglas, and three such craft have been purchased from U. S. surplus for Toronto-New York and Montreal-Ottawa-Toronto-Windsor runs scheduled for early December.

Rolls Royce, Ltd., England, has established technical office at Montreal, and plans factory at Toronto for engine service and overhaul. Company is working closely with RCAF, Canadian airlines, and government-owned Turbo Research Ltd., Toronto, to promote use of its Derwent gas-turbine jet engine.

Northwest Industries, Ltd., Edmonton, has started to make Bellanca Skyrockets and will also build latter's Aircruiser, using reconditioned 550 hp. P & W Wasps. Company is licensed to export the aircraft and also sell in Canada and Alaska.

Flying Club items: Royal Canadian Flying Club Assn. is handling all club-use purchases of surplus aircraft from government disposal organization, War Assets Corp., and puts this equipment in flying condition. . . . Former RCAF Group Capt. G. Welstead has been hired as secy.-mgr. and will use Cessna Crane twin-engine transport to visit clubs on help-visits. . . . Toronto Flying Club, largest Canadian lightplane group, has acquired 14 de Havilland Tiger Moths and will buy 3 Cessna Cranes from War Assets Corp. Also, many other of the 23 Canadian clubs have started post-war operations with surplus Tiger Moths.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

High authority says defense against atomic bombs carried by rockets (or airplanes, some of which would always get through) is improbable. If they are right, we have for the first time in history a weapon with no counter measure. Never before have defense authorities been so uncertain as to the value of existing weapons.

A hundred years from now, if the nations are still resorting to power of arms as the trump card in international relations, historians will write the Americans and English down for the champion chumps of all time, for not taking over while they had the chance. On the other hand, if law and order is attained, we'll be collectively sainted.

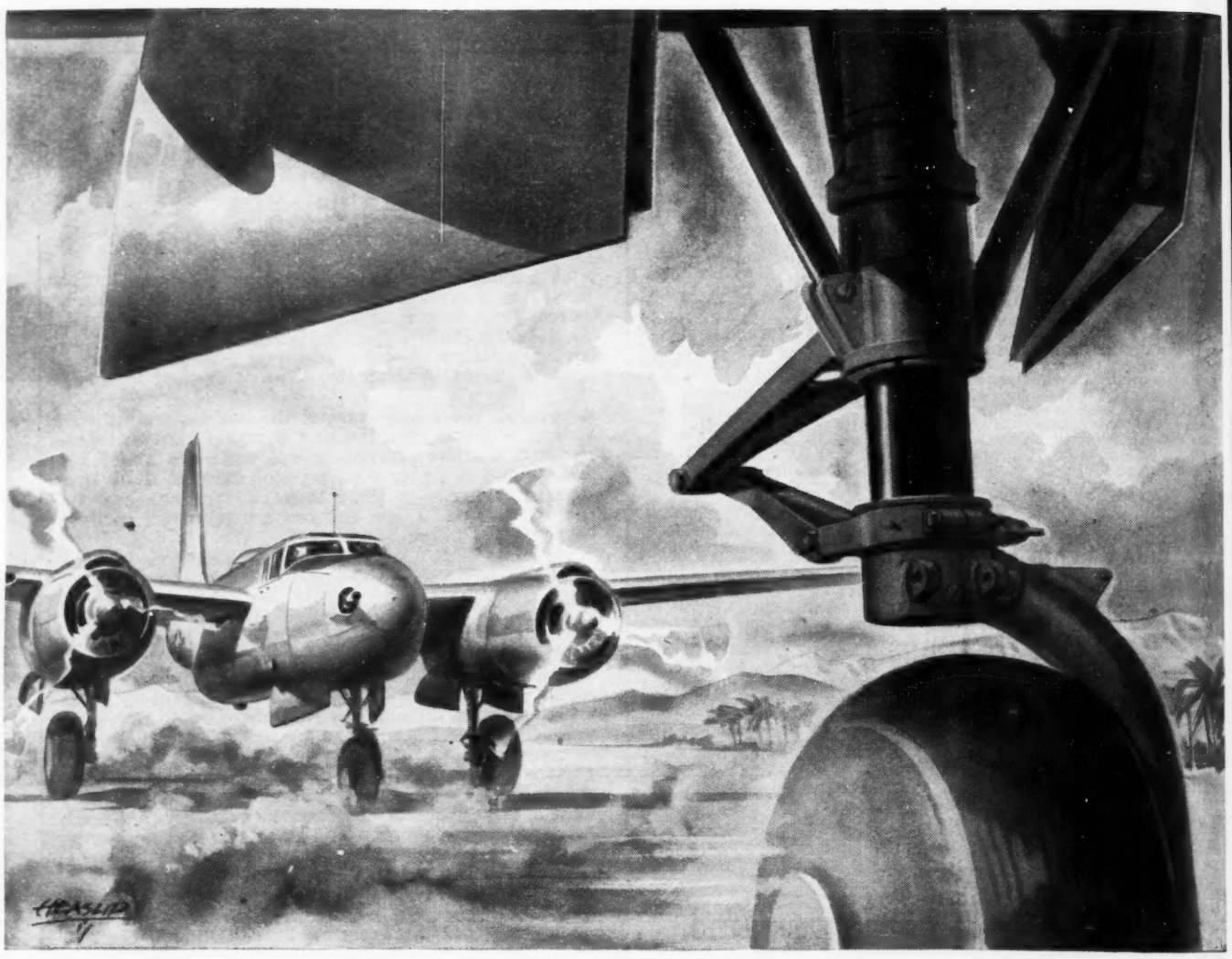
Again, as in the past, groups in Congress propose to sever CAB and CAA from the Commerce Department. Personnel in the Authority itself are split on the issue. Republicans and some Democrats may demand CAA-CAB independence as their price for passing other aviation legislation, such as the airport program. Prestige of Commerce is growing, but any advantage there may be off-set by conservative opposition to Secretary Wallace. Outcome unpredictable.

Light weight of atomic bombs, if such missiles displace conventional types, could bring about design of very light high-performance bombers even smaller than some fighters. Heavy planes would still be needed for troops, supplies, incendiaries.

There is no point in further controversy whether aviation shall be "recognized" by Army and Navy, or be given "equal" status. Navy Secretary Forrestal points out that the Cominch's entire staff could be Air, yet still would be called Navy.

GIVE UP, SOLDIER, THERE AIN'T NO PILOT

Just off Army's secret list is OQ-14, pilotless radio-controlled target plane used both by aerial gunnery and radar students as AAF went all-out for combat realism in training. Produced by Radioplane Co. of Van Nuys, Calif., and Globe Corp. of Joliet, Ill., OQ-14 has span of 11 ft. 6 in., length of 9 ft. and, powered by 22-hp. two-cylinder opposed gasoline engine, has speed of 140 mph. Catapulted into air from portable ramp, plane's steel tube fuselage is built ruggedly enough to take landing stresses. Radio-controlled parachute brings it gently to earth if vital parts are shot up. (Press Assn. photo)



The "*lighter touch*" in landings

Swooping in smoothly on emergency runways results from consummate skill by the pilot combined with efficient shock absorption by Aerol landing gear. ◆ Aerols have contributed to aviation's progress for almost 20 years, and new units now being developed for future giants of the sky, testify to the importance of Aerols in post-war aviation. ◆ Our products, serving many industrial fields, are mentioned below. Whatever your needs, Cleveland Pneumatic engineers offer you the benefit of over 50 years manufacturing experience.

THE CLEVELAND PNEUMATIC TOOL CO., Cleveland 5, Ohio

Buy Victory Bonds!

Reconversion Is Hobbled by Questions Of Peace Needs, Surplus Planes, Plants

. . . Supply of war aircraft now topping demand . . . ATSC briefs war record . . . Slate hearings on bills to push research . . . Report sales and leases of surplus plants.

Uncertainty in Government policy on military aircraft requirements for peacetime, and disposal of surplus airplanes and aircraft plants, is seriously hampering the industry in its efforts toward rapid reconversion and re-employment. This opinion is widely expressed by manufacturers, and specifically by E. E. Wilson, president of the Aircraft Industries Assn.

Army and Navy and all military authority is extremely hard put to make defense decisions, in view of unknown prospects for success of the world security organization, and of the unmeasurable potentialities of new weapons—such as A-bombs, guided missiles, and improved incendiaries.

Time alone can answer those questions. Meanwhile, it seems likely that Congress is prepared to support defense industries, especially those allied with aviation, more effectively than it did in the last peace period. Indications are that research and development projects will be bigger and more plentiful, and on a negotiated cost-plus-fee basis. Government procurement agencies probably will get more latitude in awarding development contracts. The Navy indicates intention to discontinue its Philadelphia "yardstick" aircraft factory, which, it may be noted, contributed only a fraction of the military output.

Most important, the industry wants, and may get, revised regulations under which the air forces, instead of the traditional 13 test units, would procure enough to equip an operational group—such as 45 for a Boeing B-29 group, or 90 for a fighter group. Continuation of Ryan FR Fireball production is cited as a practical example of proving the merit of a new type.

Navy's present plans call for about 12,000 planes, with 8,000 in active status. Unofficial estimates call for an Army force of from 7,500 to 12,000 planes.

Supply of War Aircraft Now Topping Demand

Already the market for surplus airplanes has passed its peak, hence there now are more planes than buyers. RFC, which sells, and the Surplus Property Administrator, who makes policy, will have an increasingly difficult job in putting on sales pressure to recover taxpayers' money, in competition with new designs. American warplanes will dribble into the markets, at home and abroad, for years.

Disposal of aircraft components is running into the same problem of decreasing demand. In time not even the fine electric motors, instruments, gears, pumps, etc., will be worth pulling out. RFC is already considering reversing its policy and requiring that justification be made when parts are **not** scrapped. It seems inevitable that most of the million unrelated items called aircraft components will be melted down or left to rust down.

RFC has granted discounts to dealers who purchase three or more airplanes, also is establishing a new agency agreement on components, and is otherwise streamlining its sales organization.

The 8,079 planes sold at this writing were 23% of 35,821 in surplus after 1,967 were turned back to Army and Navy for salvage. But the $95,000,000 cost of the planes sold was only 5% of the $2,000,000,000 total inventory. Those sold brought more than 19% of their cost. All sales are liaison, primary trainer, and transport. AT and BT types hardly sell at all; liaisons are sold out 90%. Most surplus declarations in the future will be combat types, mostly unsaleable.

ATSC Briefs War Record

Air Technical Service Command at Wright Field has issued a 20-page statement setting forth its war record—supply and maintenance of all AAF planes and equipment throughout the world—300,000 produced by American industry since Jan., 1941, with 700,000 engines. Discussed are: The B-29 program, aero medicine, new materials, self-sealing tanks, fighter range extension, improvements in airborne guns, sonic speeds, rescue equipment, supply of 750,000 items to AAF, disbursement of $50 billion and accounting for it, conversion of industry for air war, and training of two million workers.

Slate Hearings on Bills To Push Research

Senate hearings were scheduled to begin, about the time of this writing, on bills which would set up a national scientific research organization to take the place of the Office of Scientific Research & Development, which headed up technological projects during the war, and which will eventually be discontinued. Aviation is interested because aircraft, especially in war, make use of many sciences—meteorology, medicine, ordnance, etc. Also, nearly every type of equipment used by land forces likewise bears pertinence to air operations.

Pending before the Military Affairs Committee is the Kilgore-Pepper-Johnson bill for a National Science Foundation, and before the Commerce Committee are bills by Sen. Warren Magnuson for a National Research Foundation and by Sen. William Fulbright for a Bureau of Scientific Research in the Department of Commerce. President Truman, in his recent message to Congress, strongly recommended research and development in defense, as well as in other lines of national interest.

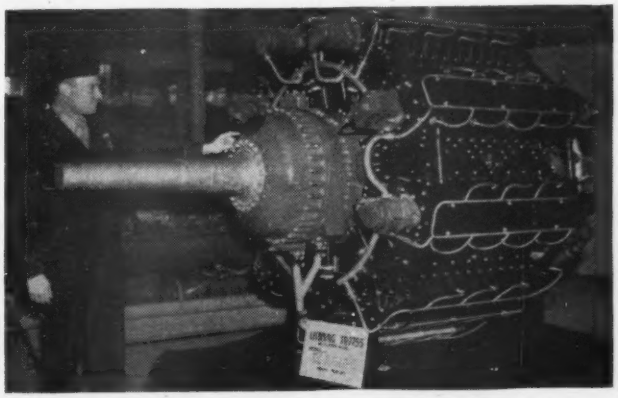
Report Sales and Leases Of Surplus Plants

RFC's latest report on surplus war plants shows that of 642 plants for sale, 34 plants, costing $45,155,000, have been sold for $33,552,000; 62 have been leased; lessees of 16 others indicate intention to purchase; and 61 are in various stages of negotiation for sale or lease. It is probable that about 1,500 war plants of all sizes and kinds eventually will be offered for sale or lease. Army and Navy and Maritime Commission will retain many of their own specialized facilities.

Of all this productive capacity, about 100 aircraft plants are mentioned in RFC's survey; these cost about $1,166,000,000. Total investment in aircraft facilities during the war was about $3,448,000,000, of which 91% was federal money.

Only six aeronautical plants had been sold, and only one of them (a plant of Engineering & Research Corp., at Riverdale, Md.) was an airframe producer. This facility was purchased by Erco at cost. Three of the six plants were acquired by their operators; two have been purchased by other than wartime operators. RFC has leased six areonautical plants, the largest being the Studebaker-operated engine plant at Chicago, which went to Western Electric.

In general, however, it can be said that the aircraft industry is shrinking back into the hands of its prewar operators, who are replacing some of their old facilities with modern RFC plant and equipment.



BIG IN MORE WAYS THAN ONE

Unveiled by ATSC at Wright Field is Lycoming XR-7755, 36-cylinder liquid cooled power plant developing 5,000 hp. with 5,500-lb. weight, making it most powe ful engine yet developed by ATSC-Industry cooperation. Though plant did not reach military operational stage, reports say a plane is currently being designed to utilize it. (Press Assn. photo)

★ KNOW-HOWS ★

Carboloy lathe center inserts, used for tube flaring at Douglas Santa Monica plant, are reported to have upped output 35 percent while increasing tool life 10 to 1 over former method.

Cam-controlled hydraulic tool feed supplied by Turchan for planing steel propeller blades is stated to have greatly increased accuracy and rate of output.

Direct fuel injection, on Boeing Superfort Wright engines equipped by Bendix, was used to obtain added range and carrying capacity on B-29s which made final runs over Japan.

FIRST IN SERVICE

TO THE AIRCRAFT INDUSTRY

• The terminals and fittings shown here were originated by American Chain & Cable especially for aircraft control. Thus we have been serving the aircraft industry almost since its beginning.

Knowledge gained through this long experience is part of the service we offer you today. We can be of real help to you on problems involving design or application of control cables and terminals.

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AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

In Business for Your Safety

ing capacity on B-29s which made final runs over Japan.

Weight saving of 8 lb. per plane was realized by UAL through removing abrasion shoes formerly used to protect wings when gravel runways were used.

Centrifugal fatigue testing machine, originated by Convair for comparing resistance of bends having different radii, is stated to have wide field in testing materials with unknown fatigue characteristics.

Automatic hydraulic router, developed by Republic under direction of H. W. Norton and S. Hyatt, designed by Allen Engineering, and built by Hydraulic Machinery Co., is reported by plane manufacturers to have reduced milling time for Boeing Superfortress cowlings to 10 min. per unit.

Spherical radii, made while cutting off finished rod ends in screw machine, are stated by Glenn L. Martin Co. to have eliminated one operation and saved considerable setup time and several sharpening operations as compared to larger radii formerly used.

★ FOR THE RECORD ★

Airquipment Co., independent division of Lockheed, has been formed to manufacture and sell aircraft ground handling equipment. C. P. "Jack" Turner (pictured on page 225) is general mgr. Offices are at 15 E. Verdugo, Burbank, Cal.

Buffalo Air Park, at Gardenville, N. Y., has been incorporated to deal in aircraft and accessories.

Edo Aircraft has inaugurated a campaign to popularize use of floatplanes on U. S. waters. Promotion is being handled by Burke Dowling of Upper Monclair, N. J.

Airpark & Personal Aviation Development Corp., of Washington, D. C., will operate Delray Beach Airpark, Fla., designed by Airways Engineering Consultants, also of Washington.

Northrop Gaines, Inc., subsidiary of Northrop Aircraft, has been formed to build lightweight hand trucks and industrial wheels, using aircraft building technique.

Curtiss-Wright announces consolidation of Clifton, N. J., and Caldwell, N. J., propeller plants to obtain higher operating economies.

B. F. Goodrich is now manufacturing Rivnuts in steel and has added brazier head type in all materials.

Stewart Bart, N.Y.C. advertising agency, is now handling Taylorcraft account.

Mercury Aircraft, Hammondsport, N. Y., has acquired Penn Yan Buses, Inc., and will transfer that business to Mercury plant.

Thompson Products, Cleveland, Ohio, announces re-organization of manufacturing operations into five divisions, utilizing both Main and Tapco plants.

Leech Aircraft, Inc., N. Y. C. distributor for Stinson, has reopened offices at 420 Lexington Ave. to handle new 4-place Voyager.

Selvage & Lee, public relations, New York and Washington, has opened a Chicago office at 1726 Field Bldg.

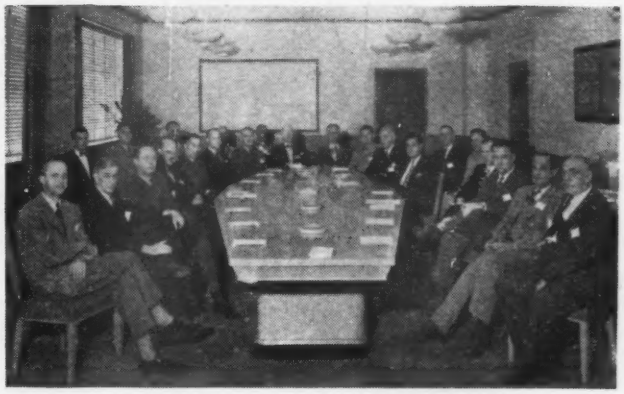
General Electric recently started work on a hangar for flight test division, to be located at Schenectady, N. Y., County Airport.

Resort Airlines, of Pinehurst, N. C., was recently organized for purpose of owning and operating airports in that state.

United Tube Corp., of Ohio, has opened a new plant at 2134 W. 53rd St., Cleveland, for manufacturing stainless and alloy tubing.

Sturdy Tool & Gage Co., 14520 Shaefer Rd., Detroit, Mich., has been formed to manufacture precision gages and plugs.

Butler Mfg. Co., Kansas City, Mo., has taken over all patent and manufacturing rights from Steel Building Div. of Globe-Wernecke Co. Steel boulevard type buildings will be featured.



NACA GETS TOP-DRAWER INDUSTRY AID

Organization of Industry Consulting Committee, group of eight industry men formed to advise NACA on research policy and prorgams, took place at this meeting at NACA Engine Research Lab in Cleveland. Around table (l to r) are: Beverly Howard, Hawthorne School of Aeronautics, consultant; Vannevar Bush, Wm. A. M. Burden, and Dr. J. C. Hunsaker, NACA; Lawrence D. Bell, Bell Aircraft Corp., consultant; William Littlewood, Adm. L. B. Richardson, George W. Lewis, and T. P. Wright, NACA; Gen. B. W. Chidlaw, AAF; J. H. Kindelberger, president of North American Aviation and Consulting Committee Chairman; consulting committeemen C. Bedell Munro, president of PCA; Robert E. Gross, president of Lockheed; Jack Frye, president of TWA; H. M. Horner, United Aircraft president and consulting committee vice-chairman; and W. T. Piper, president of Piper Aircraft. Back Row (l. to r.): T. L. K. Smull, NACA and Consulting Committee engineering secretary; E. R. Sharp, NACA; Col. D. N. Putt, AAF; Capt. Robert S. Hatcher, Navy BuAer; Grover Loening and John F. Victory, NACA; and Col. P. H. Kemmer, AAF.

★ ASSEMBLY LINES ★

Lockheed now has $137,606,272 military backlog, with existing P-80 contracts for over 900 craft extending well into '47. In addition, company is continuing development and pilot-line production of still-secret XP2V long-range bomber and experimental work on large long-range cargo planes for AAF and Navy. Orders for 103 Constellations have been received from eight airlines, with conditional orders on hand for new Constitution airliner and twin-engine Saturn feederliner. Company is now studying one, two, three, and four-place personal types for possible mass production. A separate manufacturing unit within Burbank facilities, to be known as Factory C, will expedite output of commercial transport craft.

Grumman is readying facilities for mass production of aluminum canoes. Experimental work began over two years ago.

Convair closed Tucson div., former modification center.

Curtiss received Navy orders for small number of improved Seahawk type, designated SC-2, with production scheduled to start early in '46.

Hamilton Standard has developed new lightweight hollow-steel propeller blade for use with Hydromatic and Super-Hydromatic propellers. Basic blade structure is stated to be analagous to that of a wing, having main structural member in form of flattened tube, providing spar effect, on which airfoil-shaped thinner outer shell is supported. Outer shell is supported chordwise between leading and trailing edges and main spar by hard sponge-rubber filler. Another feature is new blade retention system achieved by having bearing faces fabricated directly to blade shank to correspond with similar races fabricated in hub. Balls are loaded into raceways at time of propeller assembly. It is stated that light weight and structure of new blade makes it possible to provide full width sections all way into hub, thus obviating need for cuffs or shank fairings.

First Douglas DC-4 now being assembled at Santa Monica plant is scheduled for delivery to WAL next month. Airline will receive two more craft in January. Unit cost is put at $500,000.

Link Aviation Devices has contracted with RFC to act as agent in reconditioning and resale of Link Trainers. Under arrangement, all commercially resaleable trainers are returned to company to be put in good order and offered for purchase by public. Sales are handled by company. Currently available are C-3 models at $1,500 each, F.O.B. Binghamton, N. Y.

Fairchild signed agreement with RFC to act as agent in disposal and distribution of government-owned surplus spare parts for PT-19s, PT-23s, and PT-26s. Parts are made available with a warranty assuring soundness.

Commonwealth started making improved two-place Skyranger personal plane, and company states that a four-place land plane and four-place amphibian are also scheduled for production in addition to three-place Trimmer amphibian.

Wright Aero has contracts for first commercial versions of famed Cyclone 18 engine. Plant will power Lockheed Constellation transports.

Simmons Worden White Co., Negley Place, Dayton, Ohio, now has booklet "101 Grinding Questions Answered" in third edition in response to heavy demand from Wright Aero, Convair, Douglas, and over 1,000 other companies as well as trade schools. Gratis booklet is in use as a training text book and also for regular plant operation.

★ CALLING NAMES ★

(*Continued from page* 211)

vair's sales organization; and **William R. Weiler** and **Robert H. Swackhamer** joined Stinson Div. sales staff.

New AA appointments: **Lt. Col. Charles R. Speers, Jr.,** has been elected regional v.-p. in charge of eastern region traffic organization; **Col. Thomas C. Gentry** has been named medical director; **Robert K. Warner** has been appointed eastern regional cargo traffic mgr.; and **Stanley Washburn, Jr.,** resumed his post as promotional director. AA Overseas has named **Julian A. Mossman** general auditor, and **Howard Edsall** is now assistant to the treasurer.

William F. Peters has been appointed resident attorney for Menasco.

Laigh C. Parker resumed his position as Delta Air Lines traffic mgr.

Ted Gilmore has been named supt. of airmail and express for Mid-Continent Airlines, and **B. A. Pugh, Jr.,** has been promoted as city traffic manager in Tulsa, Okla.

UAL appointments: **Col. Ray W. Ireland** has been elected v.-p.; **Lt. Col. Gail Borden** joined airline to take over special problems and assignments as asst. to pres.; **Lt. Col. O. C. Enge** returned as district traffic mgr. in Washington; **Karl P. Hughes** became asst. traffic mgr. in that city; **Richard W. Goosdpeed** has been named interline traffic mgr.; **T. H. Showalter** is new Cheyenne base regional personnel director; and **James F. Reilly** has been appointed counsel in Washington. **Cyril C. Thompson** resigned as v.-p.-public relations. **R. D. Kelly** has been elected by SAE to Daniel Guggenheim board of awards.

Capt. Asa Rountree, Jr., resumed post as director of aeronautics for Alabama.

NAL appointments: **D. H. Amos** has been named mgr. of personnel dept. for entire airline; **L. W. Dymond** has been made asst. to v.-p. in charge of operations; and **P. A. Williams** has been appointed asst. chief flight supt.

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FACTORY STOCK

Thousands of square feet of stock rooms at the Worcester factory containing over 18,000 different abrasive items.

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Well-stocked warehouses in five industrial centers—Chicago, Detroit, Cleveland, Pittsburgh and Philadelphia.

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Over 200 distributors in 184 cities with stocks selected to meet local needs.

And in Types and Sizes for Every Grinding Job

RECONVERSION may bring you new grinding problems, but you can be sure of finding the right wheels to solve them in the Norton line—and stocked handy to you.

There are wheels in several varieties of Alundum abrasive (including the new record-breaking 57 Alundum) for grinding steels and steel alloys; wheels of Crystolon abrasive for cast iron, brass, and the light metals; and Norton diamond wheels for the carbides, glass, porcelain, and other unusual jobs. Bonds include B-E vitrified, resinoid, rubber, shellac, and silicate. And of course there's the patented Norton Controlled Structure process of manufacture.

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NORTON ABRASIVES

Hawaii and South Africa Cases Prominent In Overseas Moves; Dutch Okay "Freedoms"

. . . Airworthiness rulings sped by CAB . . . Airline traffic rocketing as fleets grow . . . CA authorized to link U.S.-Canada capitals.

Struggle for position in overseas and international aviation grows lively as American flag foreign services prepare for full-scale operations.

Oral argument before CAB in the Hawaiian Case, in which examiners recommended United Air Lines to compete against Pan American for Coast-Islands traffic, brought renewed efforts by Matson Navigation Co. for participation through an auxiliary services. Matson's argument that shipline air auxiliaries would be in the public interest was supported by the National Federation of American Shipping and the Maritime Commission. Pan American protested that competition on the route would be destructive.

Meanwhile CAB examiners have recommended award to Pan American of a route between the U. S. and the Union of South Africa. Observers noted with interest that CAB narrowed the field of applicants down to PAA and the American South African Line, the latter steamship operators since 1926. Favorable consideration of ASAL seems to indicate Board belief that surface carriers are eligible under the law. The line was ruled out, however, because the proposed service would not be "auxiliary and supplementary."

Concurrently the Netherlands government dealt a high card to U. S. overseas aviation by removing a previous reservation and endorsing all five of the "Five Freedoms" proposed by the American delegation at Chicago, after failure to reach an agreement with Britain on economic regulation of international airlines. The Dutch endorsement markedly weakens England's position, and greatly improves that of the United States in Europe. Undoubtedly this move by the Netherlands, which was and may still be a leading power in air transport, undoubtedly will strongly influence other countries to stand with the U. S. in its freedom-of-the-air policy.

Air Transport Command's round-the-world service, once a week, is a prestige builder for the AAF, and it will produce valuable information for the certificated airlines. It merely formalizes military air services in operation during the war. It will not be long before commercial passengers can fly a schedule around the world. ATC will not carry any traffic that could be handled by certificated lines.

Germany will be linked by air with the U. S. about the year-end, when Pan American and American Export (changed to American Airlines Overseas) make European connections. American flight rights over Germany will be arranged with representatives of the other occupying powers: Russia, England, and France. Within the coming year it is expected that U. S. routes will be certificated for connections with Japan.

Although most observers agree that Pan American's fight for corporate ownership of all U. S. foreign airlines is lost, it is expected in Washington that Sen. Pat McCarran, whose previous bill was killed in committee, will introduce another measure, which would also serve to force jurisdiction by the Senate Interstate Commerce Committee instead of the Commerce Committee, which won the previous battle.

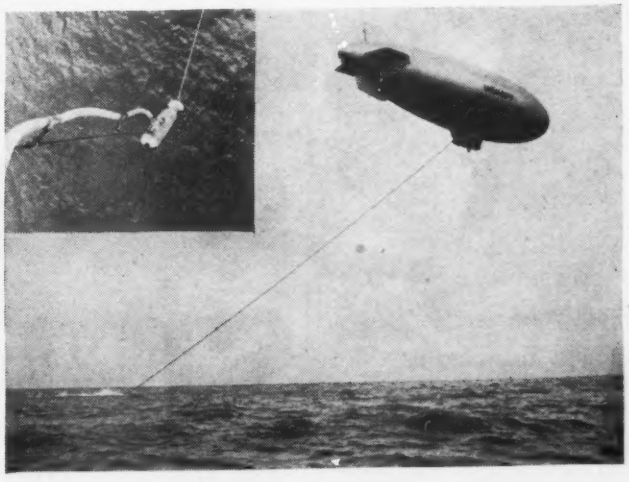
Airworthiness Rulings Sped by CAB

To enable manufacturers of transport aircraft to go ahead with development and production, and in promotion of rapid reconversion and employment, CAB has announced its decision on important points relating to airworthiness requirements in the transport category. A complete text of new regulations, CAR Part 04, was promised in the near future.

Interested persons should read the Board's text in detail. Following are the decisions in brief:

1. Regulations are optional until Jan. 1, 1948, when they become mandatory, with certain exceptions.
2. Present fixed numerical limit on stalling speed is removed.
3. Rate of climb requirements shall be met with cowl flaps set for cooling under hot-day conditions.
4. There shall be a minimum rate of climb in the cruising configuration, with all engines operating at maximum continuous power, which shall be a function of the stalling speed.
5. Minimum climb rate with one engine out, in cruising configuration at 5,000 ft., shall be the basis for type certification; it shall vary with gross weight of the airplane in accordance with a formula given in CAB's statement.
6. For airplanes with four or more engines there shall be a minimum requirement based on stalling speed for the rate of climb in the cruising configuration with two engines inoperative and with maximum continuous power on the remaining engines.
7. Clear stall warning shall be apparent to the pilot at a speed at least 5% above stalling speed with flaps and landing gear in any position, and in either straight or turning flight.
8. Aircraft may be certificated at a takeoff weight not in excess of 105% of landing weight without means for dumping fuel.
9. There shall be no separate requirements established for cargo aircraft at this time.

Factors on which CAB based its decision to eliminate fixed stalling speed are outlined in the announcement.



BALLASTING ON THE FLY

Goodyear K-10 type blimp over Lake Erie takes on ballast—without losing speed—to compensate for weight lost as fuel is expended, thus eliminating need for valving off precious helium lifting gas. Inset shows special water-pickup "fish" being lowered into water. After it hits, electric pump, plus forward speed of some 50 mph., boosts ballast water into tanks inside craft. (Press Assn. & Goodyear photos)

Airline Traffic Rocketing As Fleets Grow

Up to 200 surplus Douglas C-54s are being received by the airlines, plus all the two-engined planes they want, and soon the carriers will be able to accommodate all comers and their freight. Operators will take most or all of the allocated planes on a lease basis. Of course, the military priorities are now off, too—so peace traffic is moving.

First batch of the big allocation by the Surplus Property Board, 20 C-54E's with latest passenger outfitting, was divided eight to Pan American and six each to American and TWA, to enable them to start North Atlantic service.

Gen. Harold L. George, chief of ATC, told operators he expects around 400 C-54s will be in surplus and available to the airlines from now through next June. Only 97 of the C-54E's were manufactured and probably 50 will be declared surplus.

Re other Douglas craft: In the two-engined category, five C-49's have been released to surplus, and there will be about 70 C-53's during the coming few months. All the C-47's the airlines want will soon be available. These will be used mostly for cargo, since they are not readily convertible to passenger service. There will be also a few more Lockheed Lodestars.

Cost of converting a military C-54 to passenger use is estimated as around $150,000. Douglas has quoted $400,000 as the price for new DC-4's, civilian version of the C-54, but production of any is considered improbable because of the larger surplus of C-54's. New plane purchases will be mostly postwar models of Douglas, Lockheed, Martin, Boeing, Fairchild, and others. Demand for new Douglas C-117's, twin-engine military passenger version of the DC-3, is uncertain.

CA Authorized to Link U.S.-Canada Capitals

Colonial Airlines has been authorized by CAB to extend its routes from Ottawa and Montreal to Washington, D. C., via Syracuse and other points, and to connect Ottawa and New York via Massena, N. Y., and Burlington, Vt. Since this involved an international decision it was approved by the President, all in accordance with a U. S.-Canadian bilateral agreement. Connecting the capitals of the two countries, the operation will enable Colonial, which has only the Montreal-New York service, to spread its existing overhead costs.

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Resistance to-

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Assurance of-

maximum flexibility or rigidity, good compression set, flame proofness, high tensile strength, high resilience, micrometric precision, flaw-free uniformity.

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high or low speeds, hermetically sealed or exposed to dust, mud, weather, subzero temperatures, precision operation or toughest service conditions.

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and, if it is humanly possible to do so, they will develop a pliable part to meet your needs. Since 1929, when Chicago Rawhide instituted its research program in the development of compounded elastomers, Sirvene engineers have perfected many hundreds of pliable parts for use under seemingly impossible conditions. They can do the same for you. The vast amount of knowledge and experience which they have accumulated as a result, is available for the solution of your particular problem.

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★ CROSS COUNTRY ★

TWA started new Detroit-St. Louis nonstop service, eliminating Dayton stop.

Lockheed Constellation recently flew round trip between Burbank and N. Y. C., covering 4,960 mi. in elapsed time of 20 hr. 58 min. Ground time was 2 hr. 18 min., and it is stated that flights were made at less than 50% power. Prior to trip, 824 flight-hours had been accumulated on craft's engines, and it is planned to carry them up to 1,000 hr. as a thorough serviceability test of the plants.

PAA: Twice-weekly N. Y.-London air service was started using 40-passenger Douglas C-54s operating on 15-hr. schedules. . . . Rio de Janeiro-Miami 48-hr. schedule was inaugurated, clipping 15 hr. from previous runs. . . . Company has placed orders for 23 Lockheed Constellations, totaling about $17,000,000. Craft will enable 21-hr. service from Los Angeles to London; Los Angeles-N. Y. in 10 hr.; Los Angeles-Singapore in 39 hr.; and Los Angeles-Tokyo in 20 hr. . . . Airline began C.O.D. service from U. S. and Canada to 41 points in Colombia. . . . Now in operation are three new Miami-Havana daily flights. . . . Company received Calif. Safety Council's annual Award of Merit for unbroken record of safety in flying during past year. . . . Panagra has ordered three Douglas DC-6s and two Lockheed Constellations.

Using Stratocruisers, Shanghai will be less than 20½ hr. from continental U. S., including stops at Dutch Harbor and Paramushiro, according to Boeing figures. San Francisco-Honolulu time is given as under 8 hr.; N. Y.-London, over North Atlantic with one stop, as a little more than 11½ hr.

KLM (Royal Dutch Airlines) reopened 9,000-mi. route from Amsterdam to Netherlands East Indies. . . . Company received six of 14 Douglas DC-4s to be used on this route, and for European service four Lockheed Constellations have been ordered for delivery next March.

NAL's board of directors has authorized negotiations for purchase of eleven Douglas DC-6s, at cost of $7,500,000.

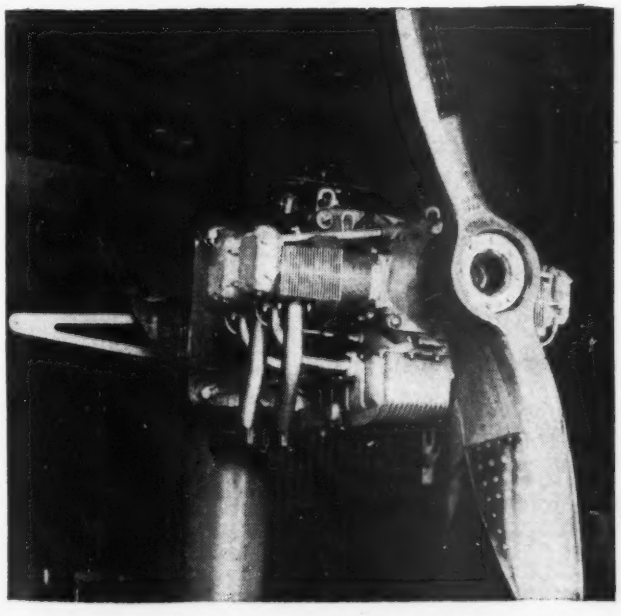
AA-Mid-Continent Airlines proposed consolidation would extend former's air cargo service along latter's routes. Omaha and Des Moines would be served by two transcontinental services to east and west; there would be one-carrier service between Minneapolis and Los Angeles with one stop at Tulsa, and between New Orleans and Los Angeles with one stop at Tulsa; and one-stop, single-carrier service would be available between all points on Mid-Continent's system and Mexico City.

CSA opened service into Fort Wayne, Ind., with north-bound trips providing schedules to Toledo and Detroit.

WAL received CAA approval to begin two-flight daily air service to San Bernardino, Palm Springs, and El Centro, Calif.

Braniff began service over new extension from Oklahoma City to Memphis via Tulsa, Fort Smith, and Little Rock.

Cleveland is planning a $21,000,000 airport expansion program, with $10,000,000 to be spent in improving present municipal Airport, $10,000,000 for a new East Side Airport, and $1,000,000 for a lakefront site for non-scheduled flying. Other plans include seven fields throughout county, central flight control of all, and air taxi and rapid transit service to Municipal Airport.



NEW 100-125 HP. DIESEL MAKES BOW

Seen on test stand is aircooled four-cylinder aircraft diesel engine developed by Fred A. Thaheld and slated for production by Diesel Power, Inc., a subsidiary of Shaffer Tool Works of La Brea, Calif. Engine develops 100 hp. at 2,400 rpm., 125 at 2,600 rpm., and has fuel consumption of .36 lb. per hp.-hr. At fuel cost of 9c per gal.—though some service stations sell as low as 5c—new engine would give fuel cost of .2c per mile. Bore and stroke are 4⅞ and 3⅞ in., respectively; piston displacement is 290 cu. in., and compression ratio 16:1. Designer reports that approximately 40 lb. can be taken off present design "heft" of 235 lb., but weight has here been made comparable to that of gasoline engines to eliminate need for re-designing aircraft using 100-125 hp. engines.

WHEN YOU NEED HEAT RESISTANCE-- the job is a natural for Carpenter STAINLESS TUBING!

You can depend upon Carpenter Stainless Tubing to stand up under continuous or intermittent attacks by heat—as well as pressure and corrosion.

This tubing does more than reduce the cost of finished parts and products. It provides an *extra margin of safety* in operation. Each length is 100% hydrostatically tested. Its walls are uniform throughout. There are no "thin spots" where heat, corrosion or pressure could get a foothold and cause failure. And the smooth Stainless Steel surfaces—cold rolled inside and out—provide further protection against heat or corrosion. Make use of our experience with designers and fabricators of products made from Welded Stainless Tubing. Ever since Carpenter pioneered the development of this type of tubing, we have added to our "know-how" . . . and used it to our customers' advantage.

CARPENTER WELDED STAINLESS TUBING sizes, shapes, analyses and corrosion resistant properties are given in this handy file folder. A note on your company letterhead will start a copy on its way to your desk, without obligation.

This Carpenter Welded Stainless Tubing heat exchanger core for an aircraft heating unit is built to withstand the terrific heat and corrosive effects of flue gases.

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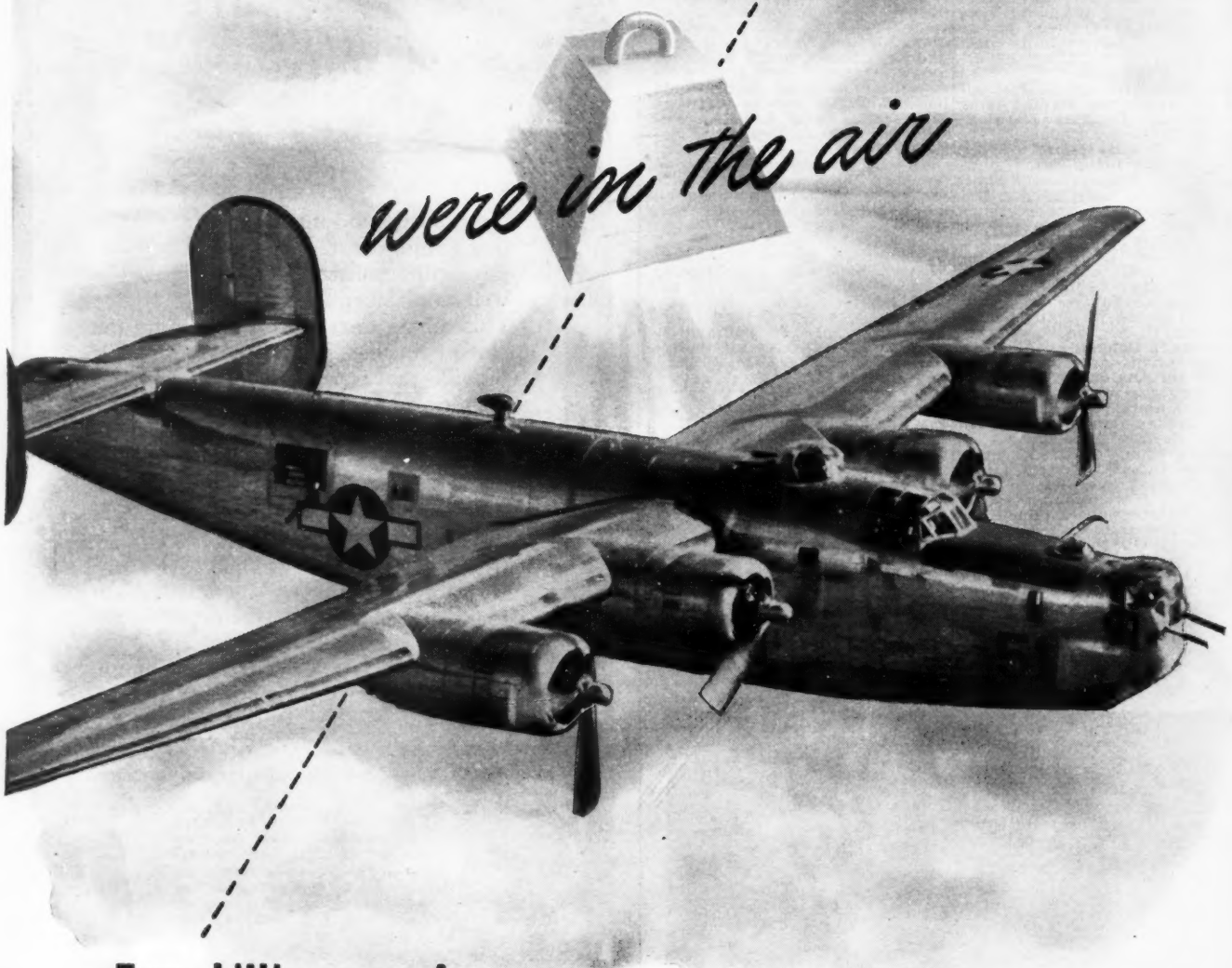
were in the air



Four-billion pounds of Alcoa Aluminum were used in building America's victorious war planes. Every single pound contained what no other aluminum can have — Alcoa's 57 years of experience and scientific research in making this metal ever stronger, better, truly dependable.

Today, this same superior aluminum is available to you . . . the manufacturers of air liners, cargo planes and personal planes. Continue to think of us here at Alcoa, not only as a source for the best aluminum, but as a storehouse of information on the application of that aluminum . . . and what's new. ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

★INTERNATIONAL BRIEFS★

ENGLAND—Short is now producing Stirling V, commercial version of famous bomber. With gross wt. of 70,000 lb. it can carry 18 passengers and 2½ tons of freight and mail for some 1,800 mi. Mail is carried in 24 bombay panniers.

RUSSIA — Expanding airline gasoline needs have forced USSR to arrange with Eugene Houdry for installation and operation of several Houdry process plants with a daily capacity of some 25,000 barrels of high octane gas.

Two airlines to U. S. are expected to start shortly, one via Western Europe across Atlantic, other via Siberia, Alaska, and Canada, to Chicago.

AUSTRALIA — Prime Minister Chiefley has proposed a Pacific Exposition to be held in Sydney in 1948, with air races starting in London and New York as part of program.

Qantas Empire Airways is now operating its 31-hr. service to Ceylon four times per week, while service to New Guinea is on a three times weekly basis. Time to London via Ceylon is 67 hr.

Keith and Ross Smith, who made first flight to Australia from England in 1922 in 28 days, recently covered same route in a Lancastrian in 63 hr.

FRANCE—The French Government airline (presumably Air France) has ordered 15 Lockheed Constellations for its routes to French colonies and America. It was stated that for sometime France will have no domestic-made planes available comparing with current U. S. types.

Orly airport, a few miles south and east of Paris, will become France's main base for international air services. It is now used as trans-Atlantic terminal by ATC. Le Bourget will be used mainly as an airfreight and mail terminal.

Paris is now connected with London, Marseilles, Nice, Tunis, Lyons, Algiers, and Casablanca. Fares are approximately 4¢ per kilometer (6½¢ per mi.), and equipment consists of Bloch 220s, Dewoitine 338s, and Junker 52s confiscated from the Germans. Three Douglas C-47s were recently obtained, and some Douglas DC-4s are expected.

DENMARK—The Danish airline, DDL, will make survey flights to America with converted Boeing B-17s, while attempting to get Douglas DC-4s allocated. It's stated that November deliveries promised by British manufacturers for Tudors can in no way be met.

Copenhagen Airport will undergo a 4-yr. expansion plan. It eventually will become one of the largest and best in the north.

EGYPT—Government has established two new departments, one to handle civil and other military aviation.

Misr Airlines and BOAC, prompted by agreements between British and Egyptian Governments, have formed new company known as Egyptian Airways, Ltd., to operate between Egypt and England.

LEBANON—U. S. Government has agreed to construct a large airport on Lebanese territory for eventual use by international airlines.

PORTUGAL — Government is studying plans for establishment of both internal and international air services. A number of de Havilland Dominies have been ordered to start some of more important domestic routes.

COLOMBIA—Pan American did not take up its option on a large block of Avianca stock, and now is holder of only 48%, balance being held by Colombian citizens.

CHILE—Southern part of Chile will soon be connected with balance of country through an air service using a series of new airports now under construction.

BOLIVIA—Lloyd Aereo Boliviano (LAB) was recently allocated a Douglas DC-3 to supplement line's small fleet of Lockheed Lodestars. Company has received financial assistance of more than $500,000 from U. S. Government for purchase of new equipment required for postwar operations.

MEXICO—CMA-Braniff battle is still in full swing. Latest development is refusal of CMA to renew an agreement permitting Aerovias Braniff to use Nuevo Laredo airport. Braniff is expected to ask CAB for permission to use Laredo, Tex., as terminal on route from Mexico City.

WORLDATA . . . . . By "VISTA"

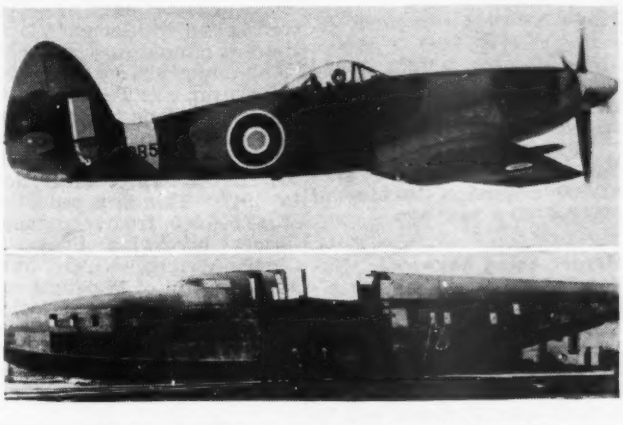
Most important development of the past month is acceptance of the so-called "fifth freedom" by the Netherlands, giving U. S. airlines the first definite base in continental Europe. It may be the first of many acceptances which would make operation of newly certificated U. S. airlines possible. Actually the acceptance is closely tied in with release of 16 Douglas DC-4s to KLM which, with newly ordered Lockheed Constellations, will be used to re-establish this line's routes. Information from Holland states that the 8,000-mi. line to the Indies will be reopened shortly on a daily schedule (maximum prewar frequency was thrice weekly), and within six months two daily trips will be offered. Plans call for two types of service, one a high-speed run via a cut-off over Indian Ocean from Ceylon, with other service more or less along prewar stations.

Plans of the two Netherlands airlines, KLM and KNILM, call for considerable expansion, both across Atlantic and Pacific. KNILM, which also orderd four Lockheed Constellations, plans services to Bombay, Nanking, Tokyo, New Zealand, and San Francisco, besides intensification of its prewar services in Netherlands East Indies. However, just what effect present political squabble in Java will have, or what would be done should an independent Indonesian Republic refuse both lines access to this area, has not been stated.

Lord Winster, new British Minister of Civil Aviation, has indicated that Britain may drop the "equal frequency" insistence for trans-Atlantic services. This is felt to be a further repurcussion of the U. S.-Holland agreement, and acceptance of the fact that the U. S. will be able to start large scale operations well before Britain, in which case a high percentage of American schedules would simply by-pass England. At the same time it was also noted that of the 38 gate positions at London's new Heath Row airport, 31 had been assigned to U. S. airlines and only 7 to the single British airline which may replace the many companies now operating.

Some disappointment is seen in the final results of the new Tudor I, which with a 76,000-lb. gross weight can carry only 12 passengers a maximum of 3,700 mi. at 295 mph., while the Tudor II will be able to carry 60 passengers for a maxium of 1,500 mi. Neither plane is felt to be the answer to Britain's needs for true long distance passenger carriers, but there is much agitation for production of both Tudors and Yorks to give English airlines some measure of equipment equality.

Airline nationalization bill in Austrailia passed by both Houses, is now law, though it has not yet been put into force, nor has the official Commission been appointed to run the new company which would be formed. However, the first case of enforcement is expected to bring immediate legal action by existing airlines, which would cause a delay of at least a year before legality of the statute can be decided. Meanwhile no new lines can be started or route extensions granted during this period, a fact causing grave concern in Australia.



BRITISH SPITEFUL AND FRENCH "IN-SPITE-OF"

Top: Shown in flight is the new Supermarine Spiteful XIV interceptor fighter, a development of evergreen Spitfire. Although basically similar to that design, new craft has larger fin, rudder, and straight-edge wings, latter possibly with laminar flow airfoil sections. Span is given as 35 ft., length 32 ft. 7½ in., height 12 ft., and wing area 210 sq. ft. Weight is 9,000 lb. (British Combine photo)

Above: Ingenuity and watchfulness paced construction of this Latecoere 631 giant flying boat which was built during German occupation. Made in a series of camouflaged huts in South France, it was assembled after liberation and recently flew from Bordeaux to Buenos Aires carrying 46 passengers. Powered by four Wright Cyclones, craft weighs 75 tons, has 188.37 ft. span, 139.26 ft. length, and is almost 34 ft. high. Fuel capacity is given as 13,260 gal., nonstop range as 6,000 mi., and top speed as 260 mph. Twin tail assembly of this craft is marked by sharp dihedral. (French Press & Information Service photo)

ADDING IT UP.....By RAY HOADLEY

Merger Rumors Sifted. From the Pacific Coast recently came news of a possible merger between California's Lockheed Aircraft Co. and New York's Curtiss-Wright Corp. to form the largest aircraft company in the world. Combined sales last year were $2,300,000,000 and combined profits were $18,850,000. No wonder Wall Street showed great interest!

How the story grew. Interests in the East characterized the merger story as "just rumors," but Lockheed's Bob Gross was more explicit. It is very logical, he said, to expect postwar mergers in the aircraft field on the basis of geographic or functional integration, such as an East Coast engine company and a West Coast plane concern. He readily admitted that Lockheeed has had talks with the Curtiss people along these lines. But at present, he added, Lockheeed has no plans to merge with anybody or to enter new industrial fields.

Consolidated and Brill. Another merger rumor that persists in Wall Street has Consolidated Vultee Aircraft acquiring the ACF-Brill Corp., maker of transport equipment. It is reported, on what is said to be good authority, that there have been some preliminary discussions but that the matter has not been voted upon by the directors of either company.

Viewing the Future. There appear to be two schools of thought among aircraft executives on the immediate future of the industry. On the one hand, Eugene E. Wilson, head of the Aircraft Industries Assn., feels that reconversion will be a long and costly process, while Guy Vaughan of Curtiss-Wright believes the aircraft industry faces a serious depression, and Donald Douglas of Douglas Aircraft cautions that the industry should view the future with "realism as well as optimism." Mr. D. cites the drop in his company's backlog of orders from $1,825,000,000 a year ago to $135,000,000 military and $101,000,000 commercial contracts.

The Other Side. However, Robert E. Gross of Lockheed feels differently. Holding that the government has been more helpful than anticipated in winding up terminations, he cites the large financial resources of the industry and is optimistic on the probable future trends of both military and commercial business. And the long-term, great untapped future buying power in aircraft, he asserts, is in the personal plane field. Lockheed has a backlog that will take nearly two years to fill, consisting of $75,500,000 in firm orders for commercial transports, another $46,300,000 in conditional transport orders, and a military backlog of $137,000,000.

Aircraft Financing. The aircraft industry is participating in the surge of industrial financing that has followed the war. Aviation Corp. has listed 375,000 additional shares of common stock to take care of options granted company officials and plans to issue 300,000 shares of new preferred stock to provide $15,000,000 of new capital. Proceeds will be applied against bank loans incurred when control of Crosley Corp. was acquired.

Airline Financing. Pennsylvania-Central Airlines has issued $10,000,000 convertible debenture bonds to finance a fleet of transport planes and to meet the cost of new ground installations. . . . TACA has arranged a $1,000,000 loan through the Export-Import Bank and a New York bank for planes and equipment.

American Buys Mid-Continent. Holders of more than 50% of Mid-Continent Airlines stock have agreed to consolidate with American Airlines whereby Mid-Continent stockholders will receive one share of American for each four shares held. Moreover, Aviation Corp., which holds 287,538 shares, or about 22% of American airlines stock, may soon announce plans for the sale of this stock. The CAB recently held that Avco's holdings constituted excessive interest in AA.

Backlogs: Northrop Aircraft has $50,000,000 of military orders still on its books after a post-surrender cutback of more than 60%. . . . Republic Aviation is reported to have more than $10,000,000 in personal plane orders. . . . Continental Motors has unfilled orders of $110,000,000 in engines and parts for delivery over next two years. . . . Bell Aircraft has received a $1,000,000 order for farm machinery engines. . . . Timm Aircraft has a $1,000,000 order for a new-type of Coca Cola vending machine.

Production Plans: Thompson Products has "reasonable expectation" that its sales will hit a stride of between $50,000,000 and $60,000,000 a year within next 15 mo. . . . Consolidated Vultee has orders for about 1,400 private planes running to $7,000,000 and plans production schedules on a basis of 3,500 planes during rest of 1945 and in 1946. . . . Solar Aircraft officials see a yearly volume ranging between $5,000,000 and $15,000,000 in future. Its current backlog is calculated to total around $10,000,000.

Lockheed Aircraft reports profits for six months ended June 30 of $1,510,421 or $1.40 a share against net profits of $2,751,562 or $2.56 a share in like 1944 period. Sales were $237,189,619 against $329,483,376.

Bendix Aviation reports net profits of $10,376,643 or $4.90 a share for nine months ended June 30 against net profits of $12,159,486 or $5.74 a share in preceding nine months. Pres. E. R. Breech said unfilled orders on Sept. 15 were $90,000,000 against a backlog of $662,000,000 a year ago.

Merger going haywire? National Airlines will not be allowed to acquire Caribbean Atlantic Airlines if CAB affirms findings of its examiners. In that case 33,500 shares of Caribbean which has been deposited with National will be returned to owners.

Fairchild Camera & Instrument Corp. reports net profits of $276,247 or 82¢ a share for six months ended June 30 against net profits of $695,054 or $2.06 a share in like 1944 period. Sales were $11,926,000 against $22,095,000. Pres. J. S. Ogsbury reported that unfilled orders on Sept. 10 were $8,656,000.

All American Aviation, Inc. reports net income of $191,771 for year ended June 30 against net income of $238,577 in preceding fiscal year. Pres. H. R. Bazley said that a $1,000,000 credit for financing war contracts expires at the close of 1945.

Continental Motors Corp. reports net profits of $3,739,384 or $1.25 for nine months ended July 31 against net profits of $4,050,757 or $1.35 a share in preceding nine months.

Delta Air Lines reports net income of $538,693 or $1.35 a share for year ended June 30, against net income of $428,606 in preceding fiscal year. Operating revenues were $5,156,282 compared with $3,233,326 in preceding year.

Transport plane orders: Pan American Airways has ordered 23 Lockheed Constellations at a cost of $17,000,000. . . . National Airlines plans to invest $7,500,000 in 11 Douglas DC-6 planes. . . . TWA has bought a fleet of 36 Lockheed Constellations at a cost of $30,000,000.

National Airlines reports net income for year ended June 30 of $169,579 or 34¢ a share against net income of $1,936 in preceding fiscal year. Operating revenues were $3,323,000 against $1,779,854 in preceding year.

Other developments: Aviation Corp. is investing some $8,000,000 in New Idea, Inc., maker of farm implements, in a cash transaction whereby $30 a share is offered for the 272,000 outstanding shares of implement firm. . . . Fairchild Engine & Airplane has amended its V-credit agreement with its bankers to provide for $17,500,000 in borrowings until Nov. 15, 1947. This is a reduction of $7,500,000 from company's former borrowing limit. . . . Curtiss-Wright, which owns 97.2% control of Wright Aeronautical Corp., does not plan to buy up remaining shares, since the management wishes to conserve its cash fund at this time.

★ OBITUARY ★

Lt. Col. Harold Evans Hartney, aviation authority and author. During World War I he commanded the 1st Pursuit Group, then he served as executive officer to Gen. William Mitchell, also directing the Army Air Service training program. He subsequently was advisor to the CAA and a Senate air safety investigating committee. A founder of the National Aeronautic Assn., he was also the recipient of high honors from this country, Britain, France, and Italy.

Eastern Airlines Silverliner by Curtiss

YESTERDAY she was ferrying tons of vital war materials over the Hump; flying stout-hearted Paratroopers into battle; hurrying wounded American boys home to peaceful safety. Known to the Army as the C-46, she was more affectionately dubbed the "flying boxcar".

Today, this tried and proved Curtiss Commando is ready for service over the important air lanes of Eastern Airlines . . . luxuriously refitted to carry 36 passengers in deep-cushioned, air-conditioned comfort. New ideas of safety and speed make her one of the world's largest, fastest and smoothest flying twin-engined transports.

These luxury planes have been made possible by the many new aircraft products that were born in the white-hot crucible of war. Many of these products were designed and built by PESCO. And now, in peace, PESCO know-how makes these precision-built hydraulic and liquid pumps and controls available to commercial aviation and other industries. For descriptive literature regarding Pressurized Power and Liquid Flow equipment, write PESCO Products Co., (division Borg-Warner), 11610 Euclid Avenue, Cleveland 6, Ohio.

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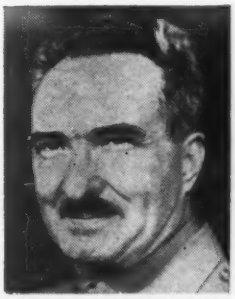
JOSEPH F. McCARTHY has been elected by United Aircraft board to office of finance chairman. Continuing as chief accounting and financial officer of company, realignment will make it possible for him to give more time to broader aspects of concern's accounting and general business affairs (John Haley photo). **WILLIAM R. ROBBINS** has been named controller, and under Mr. McCarthy's supervision, he will hold immediate responsibility for all accounting and financial matters of company and subsidiaries. Recent office he has been holding as general accountant has been discontinued.

PAUL DUNCAN MEYERS, formerly with 14th Air Force, has been named asst. to pres. of Colonial Airlines. A flyer in last war, he later was with **CAA** in charge of airport engineering and construction in N. Y. district. He was named on All-American football team in 1919.

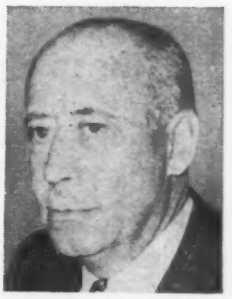


BRIG. GEN. HAROLD R. HARRIS has been elected vice-pres. and general mgr. of American Airlines Overseas, Inc., formerly **AEA.** A command pilot with 5,500 hr. to his credit, he left Panagra to join **ATC** as a colonel. He began his flying career in World War I, and from 1918 to 1925 was test pilot and chief of flight test section of Air Corps. At one time he held 13 world aviation records. **L. G. FITZ** is new vice-pres. in charge of operations. Also a veteran of World Wars I and II, he was with **TWA** when called to active duty as chief of operations for **ATC.** He is a member of many aviation and service organizations.

ROBERT L. EARLE has been placed in complete charge of C-W's Airplane and Propeller Divisions. He joined company in 1929, became Washington representative in 1933, was made asst. to general mgr. of Airplane div. Buffalo plant in 1937, and became a vice-pres. of corp. in 1939. He was elected to board in 1941. **RAYMOND W. YOUNG** has been appointed vice-pres. in charge of engineering. Coming to company in 1925, he directed development of original Cyclone 18 and has also contributed to turbo-supercharger work. As chief engineer, he ushered company into gas turbine field over a year ago.

WILLARD "BILL" LANDERS is new head of Fairchild Aircraft Div.'s production dept. Associated with industry for 12 yrs., he was formerly with **NAA** as general supt. of company's Texas Div. In his new post he will supervise manufacture of company's C-82 Packet.

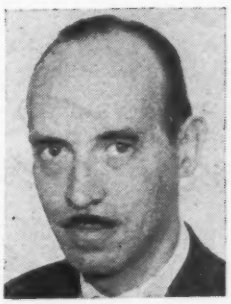
LT. COL. LOUIS KELLY, of ATC's European div., returned to American Express Co. to direct air transport div. With **AAF** he was in charge of scheduling and moving of all traffic in **ETO** and Mediterranean. Before entering service he managed company's Boston office.



LEROY D. KILEY has been appointed general mgr. of Bendix Aviation's Friez Instrument Div. Associated with Bendix for past four years as head of new devices section, his new post calls for direction of reconversion and operations. He was a bombardment pilot in World War I.

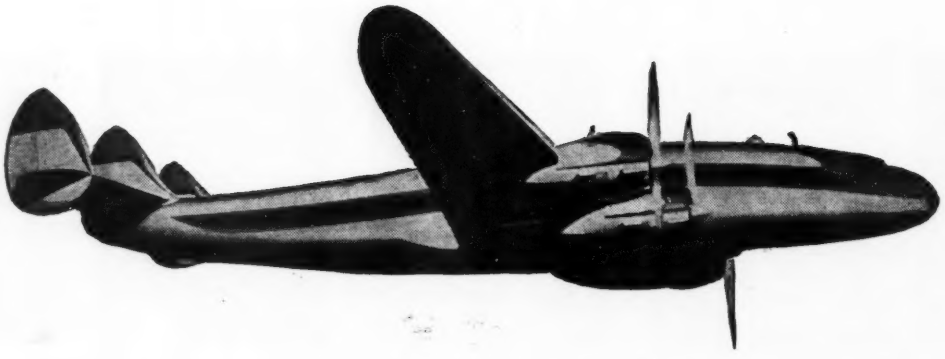
C. P. "JACK" TURNER has been named general mgr. of **Airquipment Co.,** new independent div. of Lockheed, which will make ground handling equipment. Employed by Lockheed for past three years in subcontracting and outside production departments, he has wide experience in sales.

GEORGE F. RYAN has been named director of sales for Engineering & Research Corp. Until recently he was a Maj. in ATC, first with Alaskan wing, then in Domestic div. Prior to entering Army he served as director and financial advisor of Mid-Continent Airlines.



KEN ELLINGTON is new director of public relations for Republic Aviation Corp. Mgr. of Aircraft Manufacturers Council, East Coast, and former mgr. of Aircraft War Production Council, East Coast, he came to aviation industry from radio networks, where he was director of news and special events for CBS. He was also radio public relations director for ACCA until Feb. 1943, and during past year as AA consultant, he acted to organize and manage AMC. **H. H. CARTWRIGHT,** recently returned from active duty as a colonel in ETO and Mediterranean, has been appointed asst. to pres.

A. D. PALMER, JR., has resigned from C-W Airplane Div. to join Burke Dowling Adams agency of Montclair, N. J., as an account executive. During his 10-yr. connection with the former company, he assisted in directing advertising program and the related promotional activities.



FLASH!

These eight great airlines have purchased 103 majestic Lockheed Constellations to serve every major country on every continent:

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THE NEW AIRLINE STANDARD

Lockheed Constellation

Look to Lockheed for Leadership — *Years Ahead in the Science of Flight*

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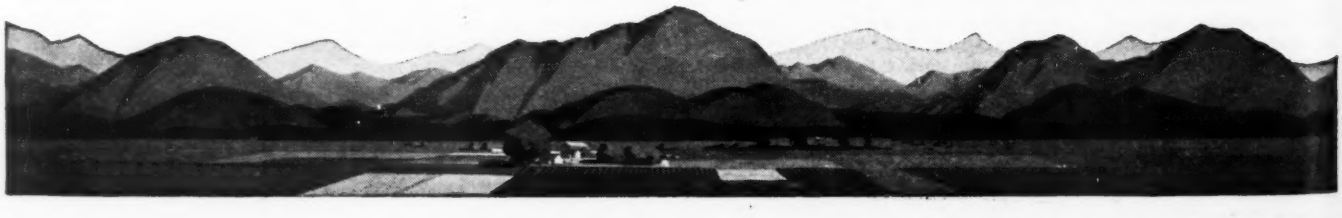


SIDE SLIPS

SO YOU DON'T BELIEVE we'll have supersonic speeds day after tomorrow? Well, it's just up to the engineers because, says a recent article on extra planetary flying possibilities, tests have shown that the human corpus can *"comfortably* withstand the shock of reaching a speed of 25,000 mph. in 8 min." The italics are ours, because a G-suit just doesn't seem to look right with slippers and a pipe.

• The greatest risk in such flying, says the piece, is that of meteorites striking the rocket, which is no greater cause for concern than the risk of crossing an ordinary highway.

You know, they'll just kill you slightly dead.

• Not long ago over in Germany an intelligence team found an invaluable electronic research device which they promptly started to disassemble and pack, all with the tenderest of necessary care. Meanwhile the instrument's presence had been reported to a general stationed at some distance. Said general promptly dispatched a cargo pilot with orders to "get that thing quick and don't come back without it."

The pilot arrived before the packing job was done to say, "Step aside, boys, I'm taking this thing back." The intelligence boys tried in vain to convince him the thing would be ruined and its benefits irrevocably lost if the packing job was not properly done. Made no difference—he had his orders, and brother, he was taking that thing back, and right now.

Anyhow, so he thought. But somehow he was enticed into a back room where he suddenly found himself securely in gaol. He stormed and fumed all night long, and he still had murder in his eye when they let him out next morning. But he calmed down some when he found the crew had worked like dogs all night to finish the packing job. And he let bygones be bygones when they said, "Okay, Junior, you can take it along now and we'll even help you load it, because we know that no matter how lousy a landing you make this thing still will be of some value to humanity."

• Flight stewards and hostesses must be a race apart, for their answers to many questions leave no room for argument. There was the young woman, for example—one who'd done enough flying to sweat out overload takeoffs—who was returning home recently after 20 months overseas service. She happened to look out the window just about over the middle of the Atlantic—and saw one prop feather and stop. When she gulped and pointed it out to the Flight Steward he calmly replied, "Yeah, we just thought we'd turn it off for a while. May turn it on later, though if we need it."

• It reminded us of a dead-o'-winter takeoff when, with about 50 ft. of altitude, both engines quit cold and stayed quit for what seemed ages, but really was just long enough to get the nose down and start heading for a flock of ice floes, only to finally rev up again.

Quite a while later we asked the stewardess, "What happened back there on the takeoff?"

She professed complete ignorance of anything at all out of the ordinary. So we reminded her: "You know, when both of our engines stopped dead."

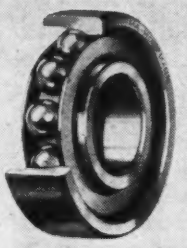
"Oh, that," she said giving us a comforting pat, "they most always do that—they're usually cold at the takeoff, you know."

• Here's one of the best arguments we've heard for adequate airport marking: Nearing the end of his gasoline supply, a cross-country flyer decided to put in at a once-familiar port. But, to his consternation, he found not a port, but a beautiful crop of corn. Seeing a farmer in a nearby open field, he circled low and asked where the airport was. No answer. He circled again and repeated his question. Still no answer, so he landed alongside said farmer and once more queried for directions.

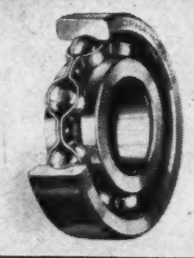
"Oh, I heard you, all right," said the soil tiller. "I just wanted to see what she looked like on the ground."

"Airplanes? Third floor, just between lingerie and household furnishings."

PRECISION BEARINGS



Separable (Magneto) Ball Bearing



Single Row Ball Bearing

FOR EVERY LOAD, SPEED AND DUTY

108 DISTINCT SERIES

BALL, ROLLER AND THRUST

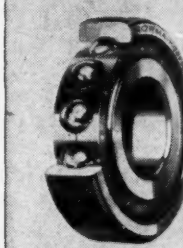
OVER 3000 SIZES

1/8" to 22 1/2" Bore—Metric and Inch Sizes

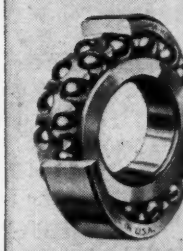
Write for the Catalog and Engineering Counsel

NORMA-HOFFMANN BEARINGS CORP'N.—STAMFORD, CONN., U. S. A.

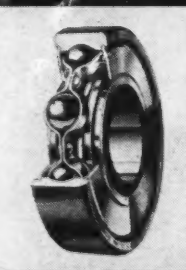
"NORMA-HOFFMANN"



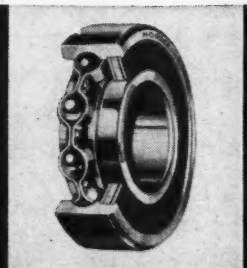
Litro ("CL") Composition Retainer Ball Bearing



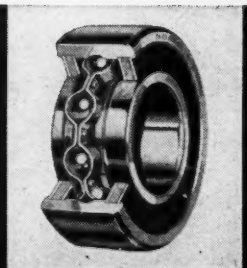
Double Row Self-Aligning Ball Bearing



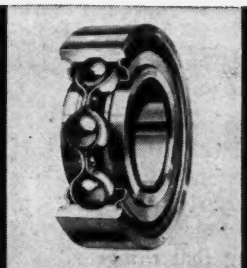
Shielded Type Single Row Ball Bearing



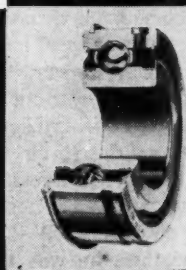
Single Felt Seal Ball Bearing



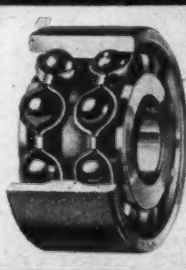
Double Felt Seal Ball Bearing



9000 Series (Feltless) Sealed Ball Bearing

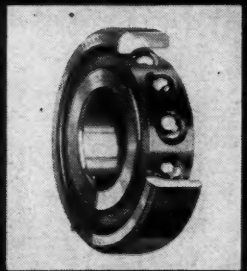


"Cartridge" Fully Sealed, Refillable Type Ball Bearing

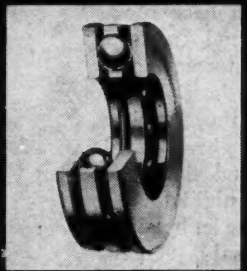


Double Row Ball Bearing

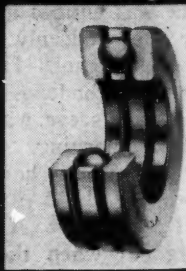
Extra Light Type Ball Bearing



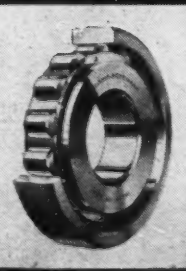
Angular Contact Ball Bearing



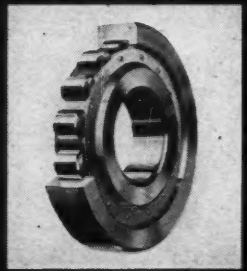
Extra Light Single Direction Ball Thrust Bearing



Single Direction Ball Thrust Bearing



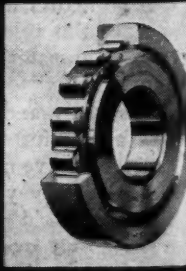
Standard Cylindrical Roller Bearing



Type "E" Cylindrical Roller Bearing

Full Type (Retainerless) Cylindrical Roller Bearing

Extra Light Cylindrical Roller Bearing



Two-Lipped Cylindrical Roller Bearing

NEW PRODUCTS

KEEP POSTED ON
Products and Practices

INFORMATION TIPS

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation

ENGINEERING DATA

Improved Insulation 1

Number of cells in "Foamglas," cellular glass insulation manufactured by Pittsburgh Corning Corp., Pittsburgh, has been increased from 5,000,000 to 10,000,000 cells per cubic foot, providing additional thermal protection.—AVIATION, Nov., '45.

Sealed Electrical Devices.....2

Methods and equipment for sealing electrical devices, such as relays, solenoids, contactors, and switches, in an inert gas atmosphere are described in new brochure from Cook Electric Co., Chicago. Also given are uses and applications as well as technical data.—AVIATION, Nov., '45.

Air Motors 3

Bulletin from Bellows Co., Akron, describes line of reciprocating air motors, giving types and methods of application together with engineering data and drawings.—AVIATION, Nov., '45.

Fuel Booster Pumps.....4

Containing engineering data, charts, and drawings, Bulletin No. 9 issued by Pesco Products Co., Div. Borg Warner Co., Cleveland, describes features and operation of fuel booster pumps.—AVIATION, Nov., '45.

Production Aid 5

Planning for Reconversion is new brochure issued by Breeze Corps., Newark, N. J., offering company's services in engineering knowledge and facilities for postwar products. It also describes firm's products for war program and part played in their development and production.—AVIATION, Nov., '45.

Needle Bearings 6

Torrington Co., Torrington, Conn., announces new manual and catalog containing engineering and application data and description of needle bearings. It gives uses in various industries and information on specifications and tolerances, load capacities, design factors, installation and inspection data, and various standards.—AVIATION, Nov., '45.

PRODUCTION

Contact Facing Alloys.....7

Bulletin No. 158 from Callite Tungsten Corp., Union City, N. J., describes "Callinite," a high conductivity facing material for high current uses where trouble is had with pitting, sticking, and welding of contacts. Other uses indicated are for facing arcing tips on air circuit breakers, motor controllers, and other industrial control contacts.—AVIATION, Nov., '45.

Sparkplug Bushings 8

"Heli-Coil" sparkplug bushings and their uses, together with pertinent tools and fixtures, are described in Bulletin No. 237-A, issued by Aircraft Screw Products Co., Long Island City, N. Y. Also contained are data on assembly and servicing and details on typical installations.—AVIATION, Nov., '45.

Aircraft Valves 9

Catalog from Kohler Co., Kohler, Wis., describes valves and fittings for use in air, gasoline, hydraulic, oil, and vacuum systems of aircraft. Included are engineering data.—AVIATION, Nov., '45.

Protection Coatings 10

New process "Unichrome Dip" for corrosion-protection coatings on cadmium and zinc is described in folder from United Chromium, New York City. Method requires one dip of 2 to 5 min. at 60 to 80 deg. giving black or olive drab finish which can be used as base for paint or lacquer.—AVIATION, Nov., '45.

Air Cylinders and Valves.....11

Non-rotating double-acting, air cylinders, also high speed rotating units, are described in Catalog No. 50 issued by Gerotor May Corp., Logansport, Ind. Also described is four-way air control valve. —AVIATION, Nov., '45.

Elastic Decals 12

"Elasti-Cals" are new decalcomanias, made of stretchable material, which can be used on rubber and other elastic surfaces. Maker is Meyercord Co., Chicago. —AVIATION, Nov., '45.

Leather Packings 13

Engineering data, description, and information on correct design of machine parts adjacent to packings are given in folder *Packing Pointers* from Graton & Knight, Worcester, Mass. Included are aids on selection of cup, flange, U-, and V-type packings.—AVIATION, Nov., '45.

Labels 14

Giving description of labels and their applications, *Tools of Business* is new catalog from Ever Ready Label Corp., New York City.—AVIATION, Nov., '45.

Lock Nuts 15

Circular from Auto-Diesel Piston Ring Co., Cleveland, describes "Auto-Diesel Sealoc" nut. These are made to form a seal and cause a compressing action, locking nut to thread.—AVIATION, Nov., '45.

MACHINERY & ACCESSORIES

Ball Bearing Tester.....16

Instrument known as "Anderometer," made by Physicists Research Co., Ann Arbor, Mich., is described in company's *Quality Control Bulletin No. 1.* Instrument is used to inspect ball bearings after assembly, sort bearings for specifications, and other uses. It is electronically operated.—AVIATION, Nov., '45.

Deep Hole Drilling.....17

Folder issued by James H. Knapp Co., Los Angeles, shows firm's "Pre-Selectric" power feeder, stated to duplicate work of a skilled mechanic when deep drilling or tapping small holes. Attachment is mounted by bracket on drill press column and provides automatic chip clearance during operation at pre-selected depths. —AVIATION, Nov., '45.

Flow meters 18

Based on rotameter principle, new "Rotasleeve", fitting standard pipe tees of sizes 3 in. and up, handles flows as large as 14,000 gpm. of liquid and 16,000 cfm. of gas. Instrument is made for direct reading, also for remote reading in recording and recording-controlling types. Information is contained in Bulletin 82-A offered by Fischer & Porter Co., Hatboro, Pa.—AVIATION, Nov., '45.

AVIATION READERS' SERVICE

NOVEMBER 1945

AVIATION, 330 W. 42nd St., New York City 18

Please send me additional information according to key numbers circled.

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NEW PRODUCTS: 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115

NAME..... TITLE.....

FIRM OR AFFILIATION.....

ADDRESS.....

Machine Tools 19

New brochure describing line of machines for multiple drilling and reaming, boring and facing, milling, also miscellaneous machines, as well as engineering data, has been issued by W. F. & John Barnes Co., Rockford, Ill.—AVIATION, Nov., '45.

Thread Milling Cutters.....20

In Bulletin No. CB-45, issued by Detroit Tap & Tool Co., Detroit, are described company's various thread milling cutters, including 52 shell and 32 shank type in virtually any thread form, both internal and external.—AVIATION, Nov., '45.

Gear Change Information.....21

New booklet issued by Michigan Tool Co., Detroit, gives complete tables for computing change gears for helical gear hobbing, plus "ball method" of obtaining exact size of internal and external involute gears, with formulas and drawings.—AVIATION, Nov., '45.

Isothermal Quenching 22

Information concerning isothermal quenching, covering both process and equipment, is given in Bulletin No. 13 from Ajax Electric Co., Philadelphia. Units and layouts are illustrated, and advantageous results of isothermal quenching process are considered.—AVIATION, Nov., '45.

Portable Infra-Red Units 23

Reflector type lamps in three sizes may be used in two new portable infra-red units designed for six and twelve lamps. These are described in new catalog page being sent out by the Carbomatic Corp., of New York City.—AVIATION, Nov., '45.

Fractional-Horsepower Drives 24

New catalog showing condensed and simplified drive tables, as well as complete specifications, has been issued by American Pulley Co., Philadelphia.—AVIATION, Nov., '45.

NO HONING!

Left-hand flutes on two blade segments spiral counter to right-hand flutes on the third blade segment shearing glass-smooth finishes in just one cut. Extension pilots available for alignment jobs. Straight line expansion from .035" in smaller sizes to .080". Blades may be resharpened 8 to 10 times, replaced economically when worn out. Sizes ½" to 3-3/32".

WRITE FOR CATALOG

LEMPCO

5497 DUNHAM ROAD • BEDFORD, OHIO

Metal Grinding and Finishing.....25

Use of idler backstands as a method of improving operations in metal grinding and finishing is treated in new brochure from Behr-Manning, Troy, N. Y. Principle of operation and method of application with equipment already in use is shown.—AVIATION, Nov., '45.

Factory Truck Battery Charger.....26

Literature describing two new battery chargers for motorized hand-lift industrial trucks, capacity one 6-cell lead acid battery and one 10-cell Edison battery, has been issued by Electric Products Co., Cleveland.—AVIATION, Nov., '45.

Infra-Red Lamp Joint.....27

A new mechanical joint between base and bulb on "Nalco" carbon filament infra-red lamps is announced by North American Electric Lamp Co., St. Louis. Method is stated to eliminate cements and other binders.—AVIATION, Nov., '45.

Hydraulic Presses 28

Bulletin No. VBS-45 from Colonial Broach Co., Detroit, gives specifications, installation data, dimensions, and description of line of standard "Utility" hydraulic presses, which range from 4-ton capacity with 24 in. stroke to 10-ton capacity with 66 in. stroke and have ram speed of 30 fpm. down and 60 fpm. return.—AVIATION, Nov., '45.

Pneumatic Tools and Lubricators.....29

New brochure from Aro Equipment Corp., Bryan, Ohio, shows line of pneumatic tools for grinding and drilling, air and hand operated lubricators, plus line of products made for military aircraft.—AVIATION, Nov., '45.

Pneumatic Die Cushions.....30

Multiple tandem type Model 2-CC pneumatic die cushion in cylinder sizes 6 in. to 24 in., having capacity for producing draw ring pressure from 6 to 100 tons, with hardened and ground pin pressure pad custom made for a given press bed, is shown in new catalog page from Dayton Rogers Mfg. Co., Minneapolis.—AVIATION, Nov., '45.

Engineers'-Glass and Scale.....31

Carrying graph of lines spaced at intervals indicating .001 in. at 50 magnifications for chart drawings and layouts used on copy tables of form and profile grinders which have pantographs and microscopes, detail engineers'-glass is described in folder from Universal Engraving & Colorplate Co., Buffalo. Also shown is layout scale with divisions of .001 in. at 50 magnifications ruled on under side of plate glass.—AVIATION, Nov., '45.

Timing Indicator 32

Booklet from Gabb Mfg. Co., East Hartford, Conn., gives description and instructions for use and maintenance of "Griffiths Time Rite Piston Position Indicator" for timing operation of airplane ignition systems.—AVIATION, Nov., '45.

X-Ray Spectrometer 33

Engineering-Design Development of X-Ray Spectrometer is new booklet from North American Phillips Co., New York City, covering basic design principles of instrument plus X-ray diffraction principles, new instrument requirements, X-ray source, pulse conditioning, frequency meter circuit, counting meter circuit, meters and controls, and applications.—AVIATION, Nov., '45.

Buffing Materials 34

Folder from Udylite Corp., Detroit, describes buffs, wheels, and compositions, giving outline of applications.—AVIATION, Nov., '45.

Blast Nozzles 35

Catalog No. 27 from American Foundry Equipment Co., Mishawaka, Ind., describes three grades of "Long-Life" blast nozzles.—AVIATION, Nov., '45.

Milling Machine 36

Plan-O-Mill Corp., Hazel Park, Mich., announces catalog describing new planetary milling machine featuring facilities for internal and external threading and milling of parts up to 2 in. I.d. or o.d. Operation is by an electronic control panel.—AVIATION, Nov., '45.

Pneumatic Hammer 37

Weighing less than 2 lb., new pneumatic hammer, described in bulletin from Superior Mfg. Co., Cleveland, operates on less than 2 cu. ft. of air at 80 to 100 psi. and delivers 13,000 blows per minute.—AVIATION, Nov., '45.

Cutting Torches 38

Illustrating and describing line of machine and hand cutting torches, new catalog from Victor Equipment Co., San Francisco, also details specifications and uses.—AVIATION, Nov., '45.

Lubrication Systems 39

New folder, *When You Reconvert,* issued by Farval Corp., Cleveland, concerns applications and describes lubrication systems consisting of a central pumping unit, two main supply lines, and a measuring valve for each bearing.—AVIATION, Nov., '45.

Electric Sander 40

Operating on straight line reciprocating action, new electric sander described in folder from Detroit Surfacing Machine Co., Detroit, can be used on plastics, metal, wood, slate, leather, or composition.—AVIATION, Nov., '45.

Belt Splice 41

New bulletin describing "Manhattan Extensible-Tip Splice" and its use with endless belts, has been issued by Manhattan Rubber Mfg. Div., Raybestos-Manhattan Co., Passaic, N. J.—AVIATION, Nov., '45.

Production Tools 42

Describing company's production tools, Catalog No. 45 has been issued by Acme Tool Co., New York City—AVIATION, Nov., '45.

Casting Salvage 43

Bulletin No. C-1A from Metallizing Co. of America, Chicago, describes new machine which circulates heated "Mogul Cast-Seal" under pressure through defective castings. Material enters cracks or pores, building up, in interlocking layers, a metallic bond which seals openings.—AVIATION, Nov., '45.

Electrical Repair Equipment.....44

Detailing line of motor-generator maintenance and repair equipment, bulletin from Ideal Commutator Dresser Co., Sycamore, Ill., describes resurfacers, precision grinders, mica undercutters, commutator saws and milling cutters, and coil winder heads. Folder from same company shows hand-and-power wire strippers.—AVIATION, Nov., '45.

Hydraulic Presses 45

Giving specifications and capacities on portable hydraulic press, catalog from Rodgers Hydraulic, Minneapolis, likewise describes shop presses, hooks and lugs for pulling, jacks, hydrostatic test units, power operated hydraulic pump units, and pipe straightening equipment.—AVIATION, Nov., '45.

Angle Dresser 46

Mounted on sine-angle plate located on magnetic chuck, new device described in literature from Nichols-Morris Corp., New York City, is designed to dress angles from 0 to 90 deg. on surface grinder wheels.—AVIATION, Nov., '45.

Gear Inspection 47

Bulletin No. 91 from Vinco Corp., Detroit, gives description, sizes, and ranges of rolling inspection fixtures for spur, spiral, worm and worm wheel, and rack and pinion type gears.—AVIATION, Nov., '45.

Welding and Cutting Equipment....48

Containing quantative data, information concerning properties and uses, and engineering data, new catalog from Air Reduction Sales Co., New York City, describes welding rods, brazing and welding flux, rods, and inserts.—AVIATION, Nov., '45.

Clamps, Bushings, Gages.....49

Literature from Products Engineering Co., Beverly Hills, Calif., gives jig drill bushing conversion data chart and covers line of tools including self-adjusting toggle clamps, A. S. A. drill bushings, gages, dimpling sets, rivet sets, and midget combination socket sets.—AVIATION, Nov., '45.

ELECTRICAL

Aluminum Connectors 50

Bulletin No. 27 from Thomas & Betts, Elizabeth, N. J., gives technical and installation data on aluminum connector lugs, explaining basic design features and tions of these electrical connection devices.—AVIATION, Nov., '45.

Communications Amplifier 51

Literature from Bendix Radio Div., Bendix Aviation Corp., Baltimore, describes "Expressor" amplifier for use with operating communications equipment, stating it eliminates background noises up to 20 decibels. It operates on 110v. 50/60 cycles, a.c. and is designed to fit 19 in. relay rack.—AVIATION, Nov., '45.

Electric Motor 52

New self-starting d.c. motor consuming from .06 to 1 watt is described in literature from Amglo Corp., Chicago. Unit is stated to operate at constant speed from dry or storage batteries or other current sources operating at potentials of 1½, 3, 6, 12, 24, 32, or 110v. — AVIATION, Nov., '45.

Motor Catalog 53

Custom Built Motors for a World of Needs is new catalog issued by Electrical Engineering & Mfg. Corp., Los Angeles, giving drawings, technical data, and descriptions of electric actuators, submersible pump motors, hub motors, dual rotation motors, inverters, generators, speed increasers, explosion proof motors, and motor alternator sets.—AVIATION, Nov., '45.

RADIO TO KEEP YOU RIGHT SIDE UP

The love-struck flier above seems to be all upset over his romance. That's something he will have to straighten out by himself, but to the hundreds of thousands who are interested in increasing the safety and security factors in aviation, Hallicrafters presents the Skyfone – two way radio telephones for the planes of tomorrow.

The Skyfone will not only keep you right side up but will keep you flying right, will protect your life, and will increase your liberty in the air.

Hallicrafters is a name you know for the best in communications equipment on special jobs. Skyfone is a name to remember as the latest addition to Hallicrafters distinguished line.

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STEELS

Stainless Strip Steels.....54

Technical data on stainless steel strips, and descriptions of properties, compositions, and applications of stainless steel, hot and cold rolled, is given in new brochure from Superior Steel Corp., Carnegie, Pa.—AVIATION, Nov., '45.

Special Purpose Alloys.....55

Carpenter Steel Co., Reading, Pa., has issued booklet *Fitting the Steel to the Job* describing uses for their special purpose industrial alloy steels. In addition there are hints on selecting alloys for specific jobs, as well as technical data. —AVIATION, Nov., '45.

Stainless Steel Sheets.....56

Handbook *Eastern Stainless Steel Sheets* from Eastern Stainless Steel Corp., Baltimore, contains pictorial information on uses of stainless steel in various industries, also applications, and information on gages, tolerances, and technical data.—AVIATION, Nov., '45.

Machining Stainless Steel.....57

A brochure of engineering data designed to aid in reducing costs, *Machining of Stainless Steels*, issued by Rustless Iron & Steel Corp., Baltimore, gives information on grade-rates, types, equipment, operations, etc., and emphasizes that change in technique, not machinery, is key to successful machining of these metals.—AVIATION, Nov., '45.

Tool Steel Manual.....58

Pocket size 170-page catalog and manual, issued by Allegheny Ludlum Steel Corp., Brackenridge, Pa., gives coverage of uses of tool steels. Liberally illustrated, it contains detailed technical data.—AVIATION, Nov., '45.

Metal Veneer 59

Giving engineering data, new literature from Ampco Metal, Milwaukee, describes metal clad sheet stated to be resistant to acid, corrosion, and rust. Accented is suitability for fabricating parts and assemblies.—AVIATION, Nov., '45.

Knife Blade Steel.....60

New bar stock combining high carbon tool steel and low carbon steel is announced by Jessop Steel Co., Washington, Pa., for use in chipper, and planer knives and for blades for cutting light metal.—AVIATION, Nov., '45.

PLASTICS & SYNTHETICS

Silicone Rubber 61

Extreme heat resistance is described as outstanding physical characteristic of new parts, such as gaskets and seals, molded of "Silastic," silicone rubber. Made by Connecticut Hard Rubber Co., New Haven, parts are stated to withstand temperature range of minus 70 deg. to plus 500 deg. F.—AVIATION, Nov., '45.

Resin Adhesive 62

Information is available on new room temperature setting resin adhesive, Penacolite G-1215, announced by Pennsylvania Coal Products Co., Petrolia, Pa. Described as characterized by 3½ hr. working life at 75 deg. F., it is stated to develop high early strength in wood joints.—AVIATION, Nov., '45.

Aircraft Windshields 63

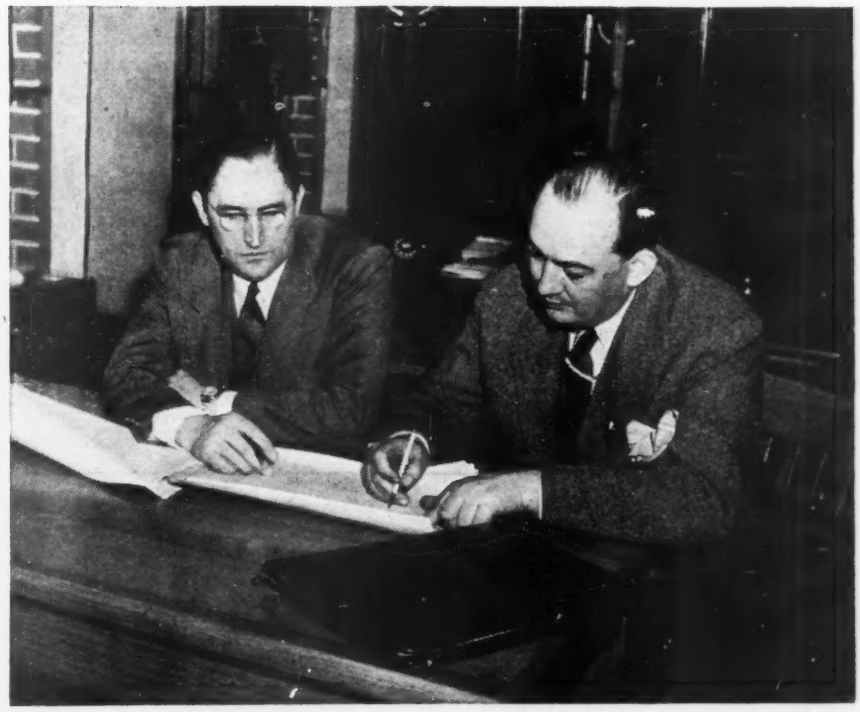
Molded in plastic in one piece, "Aero-Veu" windshields are described in new pamphlet from Aeroplastic Co., Michigan City, Ind.—AVIATION, Nov., '45.

Laminated Plastics 64

Handbook from Taylor Fibre Co., Norristown, Pa., gives engineering data and description of laminated plastics plus latest shop practices for machining material and for maintenance of tools.—AVIATION, Nov., '45.

Plastics Classifications 65

Covering thermosetting and thermoplastic molding materials, classification chart from Society of the Plastics Industry, New York City, gives values for their mechanical, electrical, optical, thermal, chemical, and aging properties.—AVIATION, Nov., '45.



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RESISTANCE TO CORROSION

In the keen postwar competition, no product can afford to carry the competitive disadvantage of extra poundage.

To gain such advantages as light weight, easy machinability, and resistance to corrosion, a recent survey covering 187 products showed that in 109 of them changes were contemplated from other metals to aluminum.

Let Acme's experienced engineering staff show you how Acme Aluminum Alloy Castings can improve your product, speed your production, and strengthen your competitive position.

Submit your blueprints or specifications for recommendations. Often a slight design modification suggested by Acme engineers reveals unsuspected possibilities for a change to aluminum castings, with its many advantages. And there's no obligation.

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PLANT MATERIALS

Paint Brush Cleaner 66

Folder from Nashway Co., Chicago, describes "Spin a Brush," hand or power driven portable machine which is stated to quickly clean paint brushes.—AVIATION, Nov., '45.

Fire Extinguishers 67

Card issued by Dugas Engineering Corp., Marinette, Wis., gives information and operating characteristics of hand fire extinguishers, including suitability, capacities, weights, effective range, and composition of charge.—AVIATION, Nov., '45.

Cast Tubes and Parts.....68

Describing centrifugally cast cylinder liners, steel tubes and parts, and bolts stated to be heat and corrosion resistant, new catalog *Acipco Steel-Centrifugally Cast* has been issued by American Cast Iron Pipe Co., Birmingham, Ala.—AVIATION, Nov., '45.

AIRPORTS

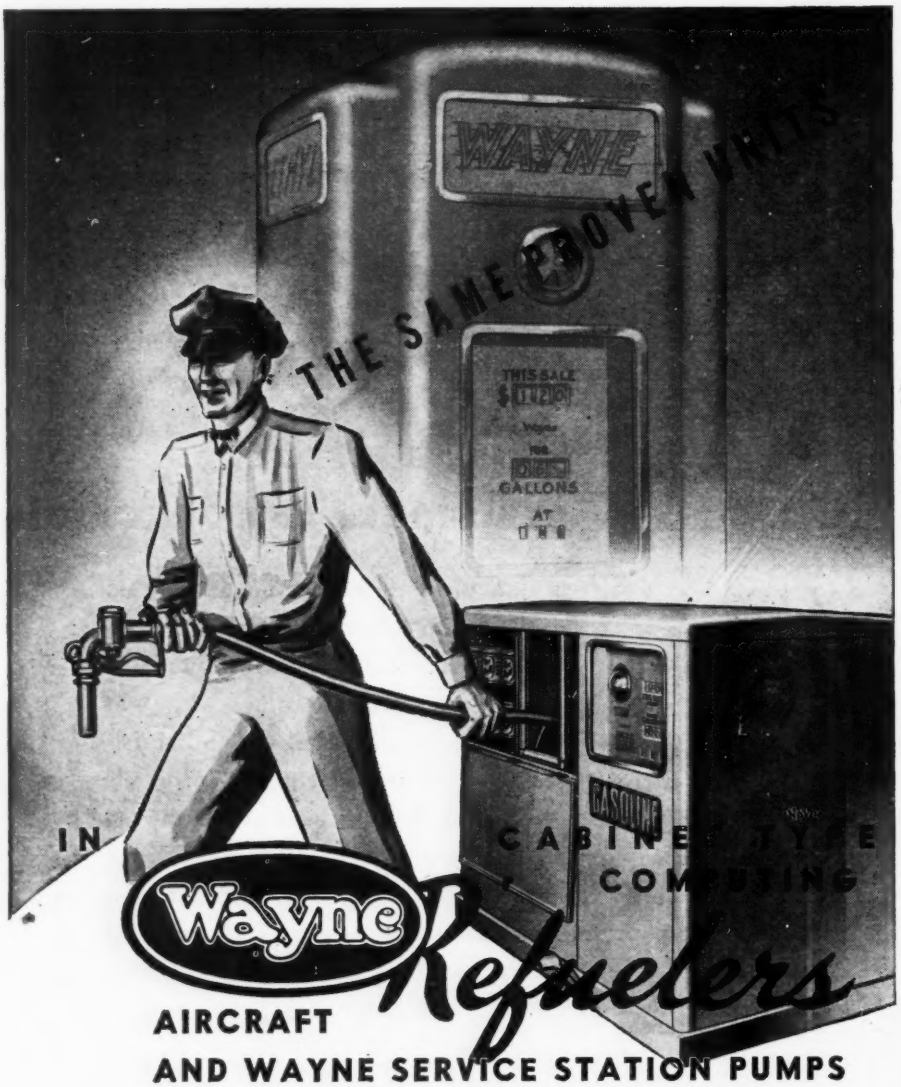
Fueling Pit 69

Both single and dual dispersal fueling pits, with capacities of 50 and 100 gpm., are described in pamphlet from Erie Meter Systems, Erie, Pa.—AVIATION, Nov., '45.

MANAGEMENT & EMPLOYEES

Employment Opportunities 70

Booklet *Your Opportunity in DFI Planned Products Service,* issued by Designers For Industry, Inc., Cleveland, describes classifications for which they need men and brief outline of qualifications and duties.—AVIATION, Nov., '45.



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ALL essential pumping, measuring, dispensing and computing mechanisms in this new Wayne airport "service station" are the same time-tested units used in the famous Wayne Service Station Pump, including the self-retrieving hose reel, plus many added refinements developed by Wayne engineers. This unit is compact, complete, easy to install. There's nothing else to buy. Storage space is provided for canned oil or other merchandise, tools, etc. Available soon. Write today for bulletin and prices.

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AIR COMPRESSORS HOSE REELS AIR SCALES CAR WASHERS LIFTS

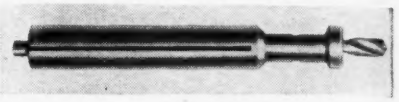
WAYNE *Airplane* REFUELING SYSTEMS

NEW PRODUCTS

Machinery & Accessories

Drill Protector 71

Hartwell Engineering Co., Los Angeles, announces new drill protector designed to reduce drill breakage. It also provides depth gage and stop. Two dimples in nose, which fit into drill flutes, drive drill,



and thereby power is applied close to drill point instead of shank. Shank is slotted, permitting chuck to grip drill with enough pressure to lock it at depth setting. Round nose protects drilled surfaces and serves as stop.—AVIATION, Nov., '45.

Boring Machine 72

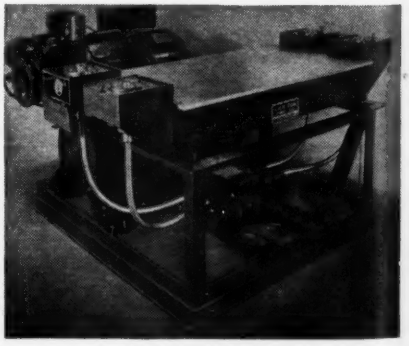
Developed to handle variety of boring, new Model C "Autometric" boring machine is made by **Kearney & Trecker Products Corp.,** Milwaukee. Stationary boring spindle head is mounted on machine column. Construction of head, spindle, and quill reduces number of sliding members. Coupled with single lever directional control to quill feeds and power rapid traverse movements, this is stated to reduce setup and operating time. Means are provided for gaging depth of quill movement to four positions. Range of spindle speeds gives efficient use of cutting tools on variety of hole diameters. Transverse and longitudinal movements of table are effected by measuring screws equipped with large diameter measuring dials and verniers graduated to .0001 in. Over-all height of machine is 90½ in.—AVIATION, Nov., '45.

Automatic Lathe 73

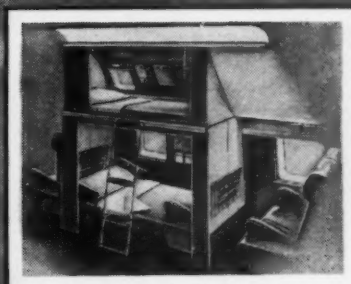
Providing automatic handling of small work, new lathe made by **Lodge & Shipley Machine Tool Co.,** Cincinnati, has dual construction. There is front and rear carriage and tool slide, each independently actuated from own feed screw. Maker states feed and traverse mechanism provides rapid forward and return traverse, wide range of mechanical feeds from pick-off gears, pause adjustment, and graduated dial for determining length of power forward traverse. Provision is made for disengaging power feed whenever necessary during cycle to return tools to start. Separate clutch lever enables operator to manually set up required cycles with hand wheel at tailstock end of each feed screw. Control levers start spindles and cycles independently from front or rear, or simultaneously from front. Setups are mechanical and no cams are required to change cycles.—AVIATION, Nov., '45. ..

Vibration Test Equipment.....74

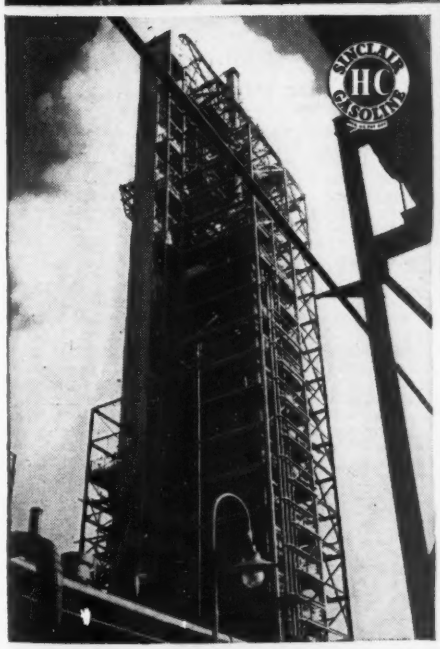
Reaction type vibration test table RV-8 is announced by **L.A.B. Corp.,** Summit, N. J. Large table is supported by four vertical rods acting as flexing columns to permit free vibration in two horizontal directions. Four sets of rotating eccentric weights induce rectilinear and pure harmonic vibrations. These weights, mounted on vertical shafts, are driven by variable speed drive through synchronizing gear box and flexible shafts. Amplitude (¼ in.



NEW YORK-MOSCOW SKY ROUTE —Giant Flagships on American Airlines *System* will directly link the principal cities of America with Europe's famous capitals via New York-Moscow Sky Routes. American Airlines has flown Flagships more than 200 million miles on Sinclair Pennsylvania Motor Oil.



Luxury in air travel! Seat and berth arrangement for Trans-Atlantic Flagships.



SINCLAIR REFINERIES have manufactured millions of barrels of 100-octane gasoline for the Armed Forces. Sinclair Aviation Gasoline will aid commercial flying on national and international routes.

CAR CARE WARNING! Your car needs change-over *NOW* to help keep it out of the junk yard. SINCLAIR-IZING by your Sinclair Dealer provides necessary servicing for *safe* cold weather driving. See your Sinclair Dealer today.

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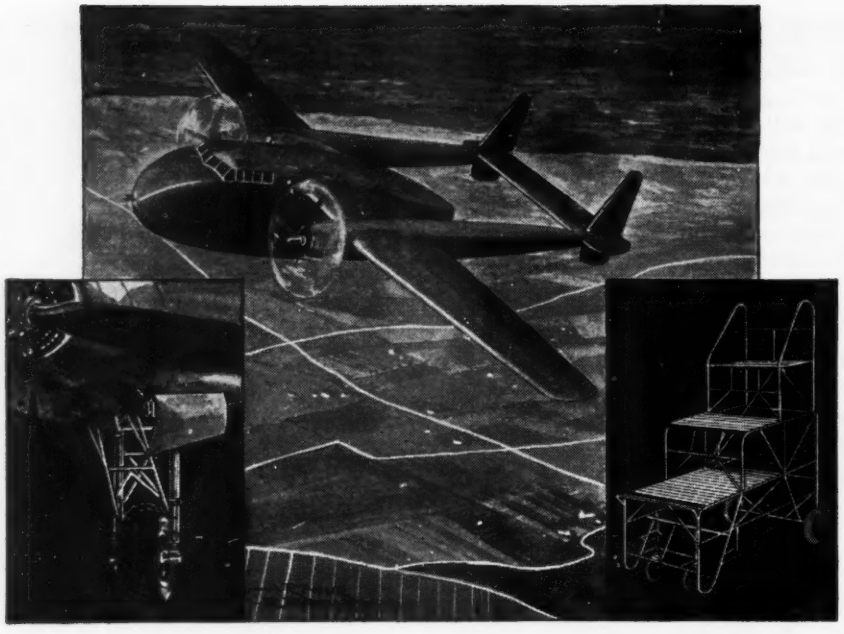


TO SPEED CARGO ABROAD

The giant of the skyways, the Fairchild designed C-82 Packet, is one of the top priority airplanes in production today. It carries a tremendous load in cargo or men and equipment on flights of 3,500 miles or more.

Aircraft Mechanics, Inc. is producing the Packet's vital nacelle support mounts.

The assignment to participate in the production of this urgently needed airplane honors us. Throughout the war period, we have produced high tensile steel forgings and welded tubular assemblies for the aircraft manufactured by more than fifty major aircraft producers. Our experience in forging and welded tubular assembly manufacture gives us the skill and ability to produce for the C-82, as scheduled.

We also are producing, on schedule, other valuable equipment necessary in the progress of the aircraft and its allied industries. Included are many items of Airport, Ramp and Hangar equipment such as passenger and cargo loading stands, nose and tail service units, battery, baggage and other supply type carts, refueling and service ladders, etc.

As we serve present customers, so can we serve you. For full information please write us, now.

BUY UNITED STATES WAR BONDS AND STAMPS

★ **AIRCRAFT MECHANICS** INC.

COLORADO SPRINGS, COLORADO

DESIGNERS ••• ENGINEERS ••• MANUFACTURERS

maximum excursion at 100 lbs. table load) and direction of vibration (horizontal, crosswise, or lengthwise) are adjustable when machine is not running. Increase in load over 100 lb. automatically reduces amplitude. Standard frequency range, 10 to 60 cycles per second, is adjustable while running, either by hand wheel or ¼ hp. motor driven automatic frequency change control, with 1 min. cycle. Amplitude does not vary with frequency. Acceleration of 10 Gs is produced by the unit at 40 cycles per second at ⅛ in. amplitude. Equipment has capacity of 400 lb., weighs 1,500 lb., and is driven by 5 hp. motor. Dimensions are 52x58x32 in. high, with table top 24x40¾ in. These vibration test tables are designed to expedite correction of design and manufacturing errors.—**AVIATION, Nov., '45.**

Split-Line Broaching Machine.....75

Special machine for broaching i.d. and split-line surface of automatic type precision half-bearing is produced by **Hydraulic Machinery, Inc.,** Dearborn, Mich. Cycle of these vertical machines is automatic, except for loading and unloading. Advantages reported are high production, positive alignment and clamping of bearing, adaptability to different sizes of nests for various sizes of bearing, and adjustable broaching speed. Machines are powered with "Hy-Mac" hydraulic power unit.—**AVIATION, Nov., '45.**

Drill Attachment 76

Consisting of a driving head with six movable spindles, new multiple drill attachment is designed to permit positioning of drills up to ¼ in. dia. in any hole pattern, including a straight line, within a 5 in. dia. circle with a minimum distance between centers of ½ in. Made by **Commander Mfg. Co.,** Chicago, attachment weighs 13 lb.—**AVIATION, Nov., '45.**

Carbide Core Drill.....77

Results of a study of effect of various carbide grades, tool shapes, shank materials, tool angles, and number of flutes, on life expectancy of core drills used on hard, scaly cast iron parts, is new type carbide tipped made-to-order core drills from **Tungsten Carbide Tool Co.,** Detroit. Maker states life of tool is greatly lengthened.—**AVIATION, Nov., '45.**

Drilling Positioner 78

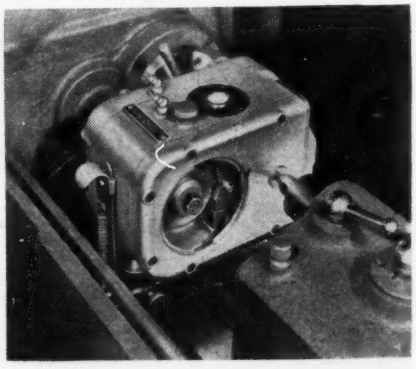
Designed to provide accurate positioning for drilling holes, "Center Scope" is announced by **Center Scope Products,** Glendale, Calif. Lens and prism in fixed positions magnify layout lines, and operator looking through lens, with scope in vertical collet of vertical boring mill, is enabled to set machine accurately, maker states.—**AVIATION, Nov., '45.**

Tube Flaring Machine.....79

Model DF "Tube Master", double or lap flaring machine designed to produce 400 to 600 double flares per hour without use of hand tools, is announced by **Leonard Precision Products Co.,** Los Angeles. Self-contained, unit is stated to require only one airline connection.—**AVIATION, Nov., '45.**

Automatic Diamond Dresser.....80

Sheffield Corp., Dayton, Ohio, announces new semi-automatic diamond dresser which converts single point thread grinders to multi-ribbed wheel work. It is mounted between centers of grinder and is actuated by driving pin on face plate. Cam for required pitch, mounted on ground and lapped spindle, controls movement of diamond. Reciprocating movement of diamond with uniform motion



imparted by lead screw gives desired wheel profiling action. At least 2½ in. clearance is required below centers and 5¼ in. is needed back of centers measured on table. Center to center requirements are 4¾ in. minimum.—AVIATION, Nov., '45.

Horizontal Boring Machine.....81

Universal Boring Machine Co., Hudson, Mass., announces redesigned and improved 3 in. horizontal boring machine. It has higher speed ranges, increase in number of speeds, and pendant type control.—AVIATION, Nov., '45.

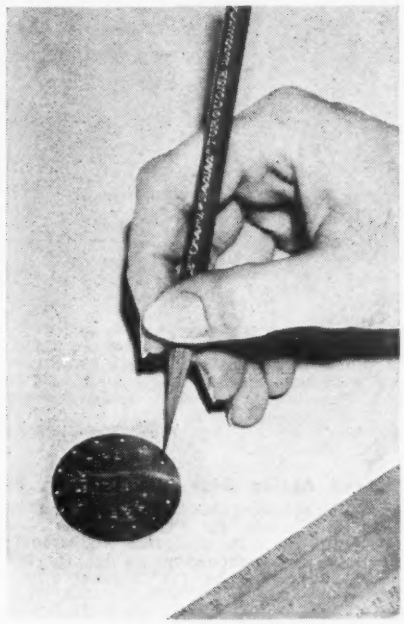
ShopEquipment & Materials

Heavy Duty Dollies.....82

Obtainable in pairs, "Skid-Rolls" made by **Techtmann Industries,** Milwaukee, are dollies for shifting machines, tanks, boxes, steel blocks, dies, furnaces, and heavy objects weighing from 10 to 12 tons. Steel cleats imbed into wood skids and carry loads a few inches from floor. It is stated load can be rolled over all types of floors and pavements, diagonally across railroad tracks, or used as turntables. Dollies are 18½x10½x4 in. high, and are equipped with 3¾ in. steel rollers lubricated with Zerk fittings. Inverted dollies can be used for moving steel beams and girders. —AVIATION, Nov., '45.

Loftsman's Scribing Disk.....83

Produced by **Topflight Tool Co.,** Towson, Md., new scribing disk is designed to eliminate errors and save time in layout of sheet metal gages used in aircraft industry. After line indicating edge of sheet



metal is drawn, draftsman inserts pencil or scriber in hole indicating required gage and pulls disk along straight edge or curved spline against which first line was drawn. Gage acts as spacer between pencil and straight edge or spline.—AVIATION, Nov., '45.

Thermoset Plastic 84

Material named "Kriston" is new thermoset plastic made by **B. F. Goodrich Chemical Co.,** Cleveland. It is stated to be non-inflammable, with high optical and electric properties, and resistant to abrasion, oils, greases, alkalies, and acids. Low temperatures and no pressure are required. Having a specific gravity of 1.25, material is a somewhat viscous, water-clear, anhydrous liquid which maker states can be cast in simple molds, setting to a hard heat resistant plastic. No water or other volatile products are released during

"They shall beat their swords into ploughshares" —ISAIAH II: 4

★ SEE BELOW

NORTON ABRASIVES

Swords to Plowshares

Conversion to peaceful pursuits will bring its own battles —to do things better, faster, cheaper and with less labor.

But there's one modern, speedy, economical method that any metal working plant can so quickly and easily adopt

METALITE BELTS IDLER BACKSTANDS

. . . with the minimum expenditure of time and money and no loss of present floor space.

Just install an Idler Backstand behind your present lathe, substitute for the set-up wheel a resilient contact wheel, slip a Metalite Cloth belt over the latter and the pulley on the backstand, and you're off to higher speeds, better finish and sweeping reductions in "cost per piece sanded."

The examples shown in our illustrated bulletin give far more convincing details than we can possibly include in this short text. Just a few lines on your letterhead asking for "Plus Factors" will bring it by return mail.

★ Left: Grinding Machete Blade. Right: Finishing Plow Points.

QUALITY ABRASIVES

BEHR-MANNING
(DIVISION OF NORTON COMPANY)
TROY, N. Y.
Quality Coated Abrasives Since 1872

Sizes up to 2" diameter — in a tin bronze, a high-lead bronze, and SAE 660 bearing bronze
Big Savings
faster production on automatic screw machines
...with Ampcoloy Continuous-Cast Bronzes

As a part of Ampco's program to provide American industry with a *complete service* on copper-base alloy parts, the continuous-casting process has been applied to the production of mill-length rods of certain bronze alloys.

This process, exclusive with Ampco as to bronzes, results in rods of close tolerance and a soundness not commercially available until now. The fine, even dispersal of the secondary constituents is truly remarkable. The rods are of good surface, uniform diameter, and even length.

Fast semi-automatic or fully automatic machines can be used, with big savings in time, manpower, and money. Tools last longer, with a sand-free surface and no internal segregation. There is less material to purchase, receive, and handle. Scrap loss due to metal faults is practically eliminated —with further savings on the handling and storing of scrap accumulations.

Write for Data Sheet 131, showing photomicrographs and properties. *Ampco Metal, Inc., Dept. A-11, Milwaukee 4, Wis. Ampco Field Offices in Principal Cities.*

Ampcoloys are a product of

Ampco Metal, Inc.

. . . specialists in engineering — production — finishing of copper-base alloy parts.

Reg. U. S. Pat. Off.

AMPCO

A-15

polymerization. Material has refractive index of about 1.57 and can be made into a clear plastic or in a range of colors which can be transparent, translucent, or opaque.—**AVIATION, Nov., '45.**

Cylindrical Plug Gage.....85

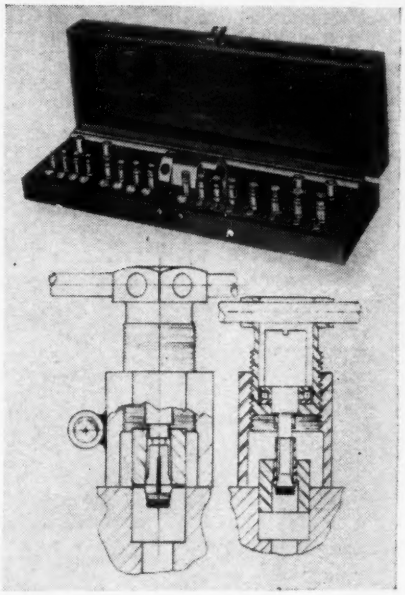
Made by **Schrillo Aero Tool Engineering Co.**, Los Angeles, new cylindrical plug gage has aluminum alloy collet type handle which positions set of wire type gages and enables user to reverse gage member after it has worn under allowable limit, thus to take advantage of unused gaging surface in handle. Gage is made in size range of $\frac{1}{8}$ to 1 in. in increments of $\frac{1}{8}$ in.—**AVIATION, Nov., '45.**

Joint Sealing Compound.....86

Containing rubber, asphalt, and other ingredients, "Careylastic" has been developed by **Phillip Carey Mfg. Co.**, Cincinnati, for sealing joints in concrete paving and construction, and to make an infiltration-proof seal. Maker states flexible bond retains resiliency and cohesion through seasonal expansion and contraction, and that due to elasticity there is no extrusion of seal or breakage of bond at low temperatures.—**AVIATION, Nov., '45.**

Die Insert Extractor.....87

Made by **Bolduc Specialties Co.**, Detroit, are extractors (patent pending) which can be used for straight or tapered hole type pierce die insert in toolroom or while die is in press. It also removes slip fit inserts



held with set screws or patented locks. Set Model B32 (illustrated) has 16 extractors with hole sizes ranging from .258 to .510. Standard sets for larger holes will soon be available and special extractors can be made to specifications.—**AVIATION, Nov., '45.**

Delayed Action Glue.....88

Capable of long flour extensions, urea resin glue made by **Perkins Glue Co.**, Lansdale, Pa., is designed to provide assembly times exceeding 24 hr. for hot press and up to 1 hr. for cold press production by use of different catalysts.—**AVIATION, Nov., '45.**

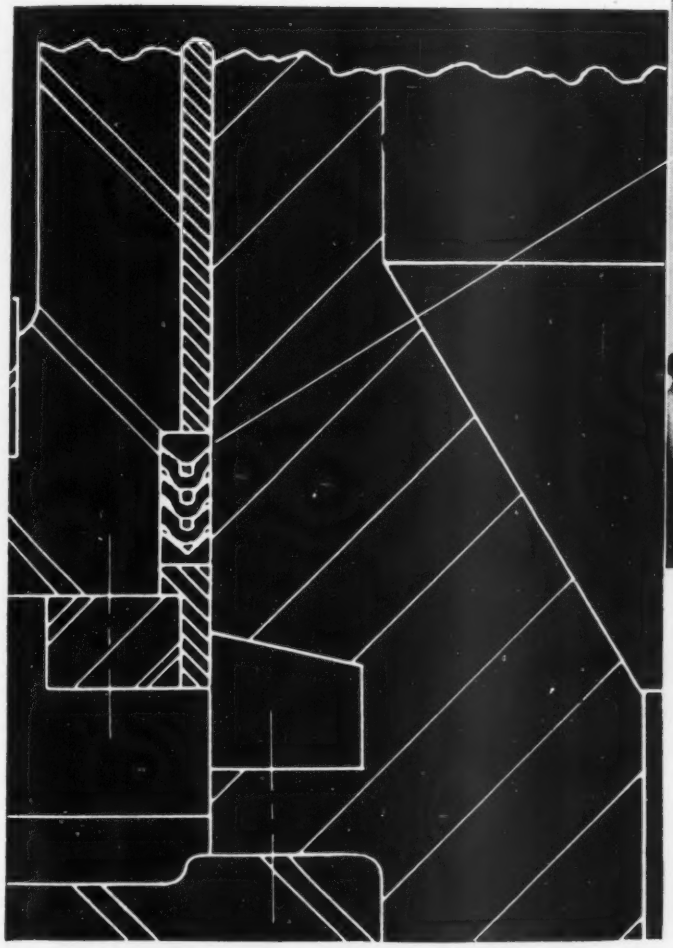
Protective Coating 89

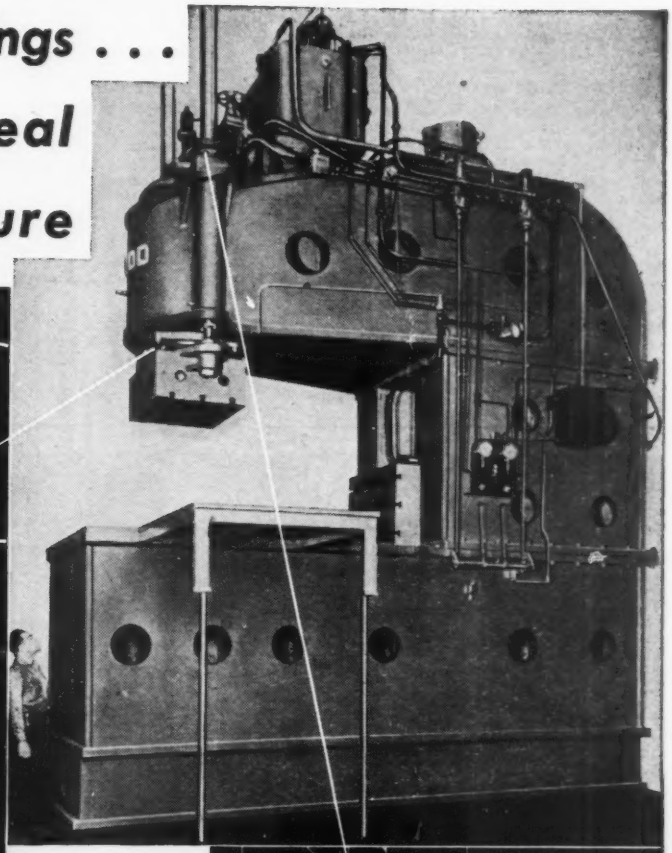
Developed to protect parts subject to deterioration from contact with either elements or other transported goods, and to resist humidity, impact, abrasion, and corrosion, "Eronel Thermo-dip" is made by **Eronel Industries**, Los Angeles. Coating is applied by hot melt technique at temperatures ranging from 280-325 deg. F., and it is removed by splitting and peeling. It can be re-melted and re-used —**AVIATION, Nov., '45.**

Carbide Lamination Die 90

Substituting carbide for high speed steel, **New England Carbide Tool Co.**, Cambridge, Mass., has developed carbide lamination die for stamping rotor laminations for small electric motors. Solid carbide is used for all operations, including cutting off, and all pilot pins are made

LINEAR "Par" Packings . . . produce a fluid-tight seal . . . for hydraulic pressure





LEFT: Main ram, 31 in. dia., 750 tons capacity; packed with Linear "Par" packings.

RIGHT: Pull back rams, also packed with Linear "Par" packings, return the main ram from its pressure position in minimum time.

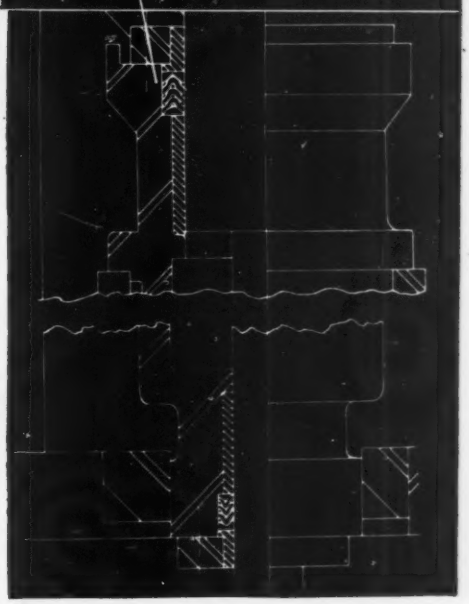


Photo and sketches courtesy R. D. Wood Company, Philadelphia.

Specifically designed for all kinds of straightening work, the R. D. Wood Company's Hydrolectric Open Gap Press is also adapted to flanging, forming, forcing or bending operations within its capacity.

For this 750-ton press, Wood designers selected Linear "Par" packings to maintain a fluid-tight seal . . . to confine the hydraulic fluid in the press without leakage, helping to develop full working pressure at the ram.

Linear's distinctive design insures a completely automatic packing. As pressure develops the lips expand—and expansion is proportionately reduced when pressure is lowered. Utmost efficiency and uniform pressure maintenance are assured from zero to peak pressures . . . extreme friction and wear are eliminated.

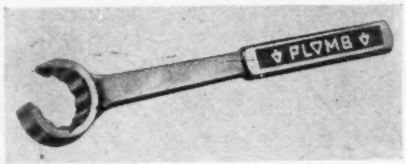
"Par" packings are made in six compositions, each for a particular service. Sample rings sent upon request. Engineering consultation always available.

LINEAR
INCORPORATED
STATE ROAD & LEVICK STREET
TACONY, PHILADELPHIA 35, PENNA.

of solid carbide to maintain accuracy. It is stated this type of die has eliminated down time on press, also need for standby dies.—AVIATION, Nov., '45.

Flare Nut Wrench.....91

Developed by **Plomb Tool Co.**, Los Angeles, for use on plastic pipe, tubing, and soft metal fittings, is new flare nut wrench



with flat head based on modified 12-point design, with opening which allows access to fittings around tubing. Uses of this wrench are in assembly and maintenance of all types of lines, including those for fluid, air, and gas. Wrench comes in following sizes: ½, 9/16, ⅝, ¾, ⅞, 15/16, 1, 1 1/16, and 1⅛ in.—AVIATION, Nov., '45.

Industrial Ovens 92

New RS industrial ovens, made by **Despatch Oven Co.**, Minneapolis, in sizes 2x2x3 ft. to 4½x6x9 ft., are stated to be adaptable for all baking and drying processes up to 500 deg. F. Built in upright position, units are self-contained and require only lead-in of gas or electricity for installation, have loading dollies, automatic controls, and controlled volatile exhaust.—AVIATION, Nov., '45.

Light Duty Vibration Mount.....93

Designed to eliminate disturbing vibration and noise from small motors, power tools, etc., new Rexon light duty vibration mount is announced by **Hamilton**

Kent Mfg. Co., Kent, Ohio. New principle of mount design is stated to combine high vibration dampening properties of rubber loaded in shear, with safety, durability and ease of installation. Five sizes of light duty mounts handle range of loads from 1 lb. to 200 lb.—AVIATION, Nov., '45.

Hole Punching Units.....94

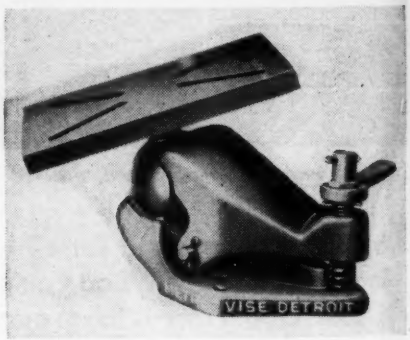
Designed to punch holes in metal up to ¼ in. thick, Type BJ hole punching units made by **Wales-Strippit Corp.**, North Tonawanda, N. Y., consist of a holder that carries punch, die, and stripping mechanism. Set-ups are made on T-slotted plates or templates for stamping presses and on rails for press brakes. Units are available in three holder widths, with maximum punch dia. of ¾ in. for use with metal up to ¼ in. thick.—AVIATION, Nov., '45.

Three-Arm Pullers 95

New line of "Griptomatic" gear and flywheel pullers, made by **Owatonna Tool Co.**, Owatonna, Minn., includes triple grip pullers in same range of sizes as two arm pullers, with both long and short arms. Arms, forcing screws, straps, and capscrews on 2- and 3-arm types are interchangeable.—AVIATION, Nov., '45.

Work Tilting Device.....96

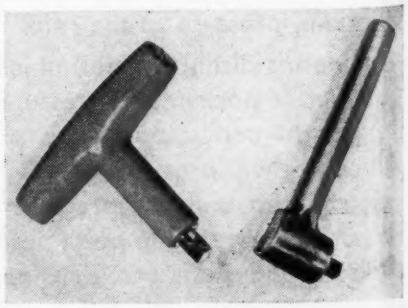
Made by **Metro-Vise Co.**, Detroit, new "Metro Positioner" is designed to permit tilting of work, during assembly operations, to various positions without adjustment. Work is bolted to plate integral



with ball turning in socket formed by two clamping jaws held under tension by spring. Tension of spring is adjusted to character of work by adjustment screw.—AVIATION, Nov., '45.

Torque Wrenches 97

New torque wrenches developed by **Jo Mfg. Co.**, South Gate, Calif., for light assembly on aircraft are designated as



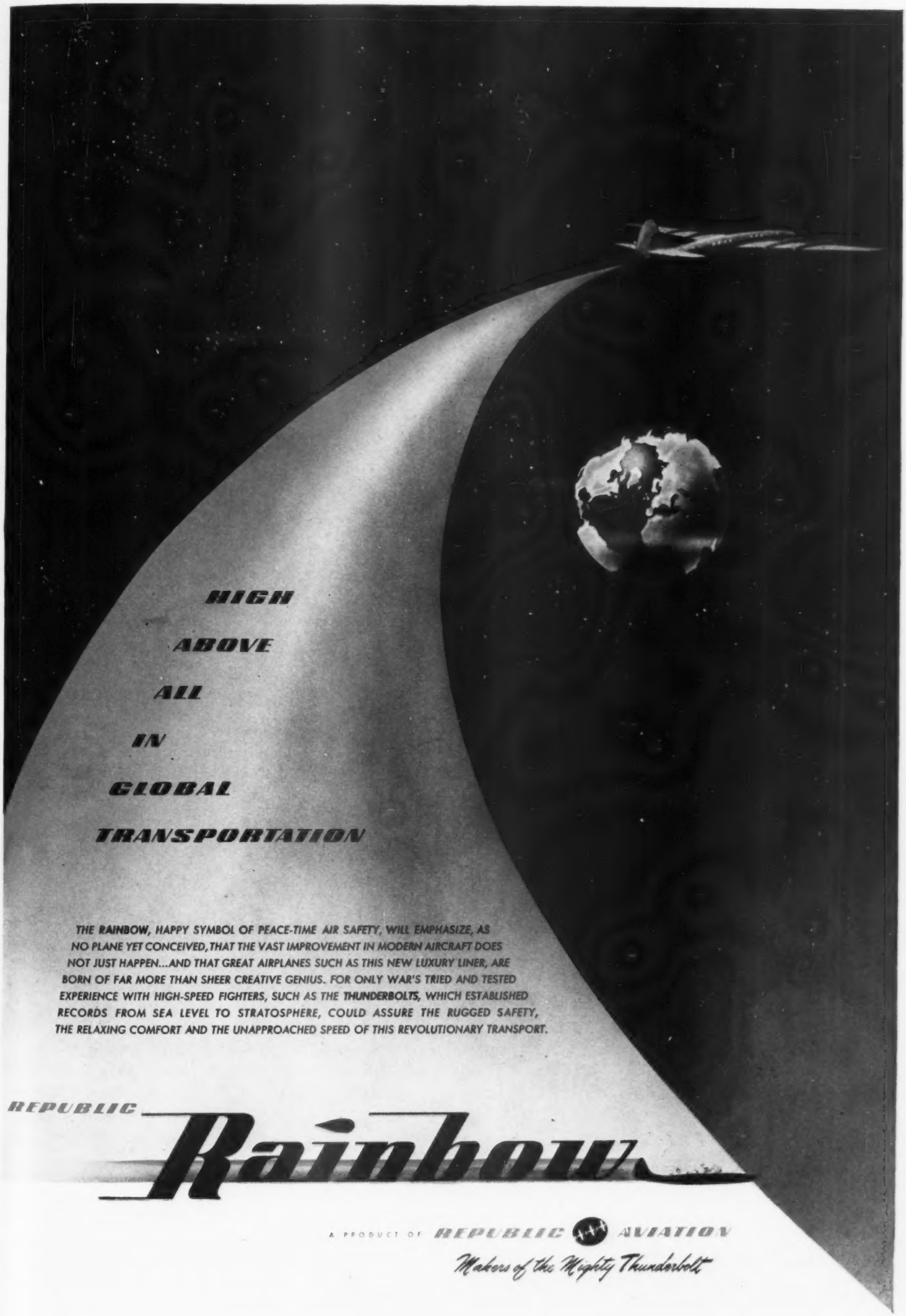
FOR highly stressed parts, it is an undisputed fact that there is no substitute for forgings. While high individual properties can be obtained by other methods of fabrication, the forging process develops the greatest combination of physical properties (tensile and compressive strength, ductility, impact and fatigue strength) and the greatest uniformity of quality of any method of manufacturing metallic shapes. Forgings are the ultimate as far as a combination of strength and toughness is concerned.

WYMAN-GORDON

Forgings of Aluminum, Magnesium, Steel

WORCESTER, MASSACHUSETTS, U. S. A.

HARVEY, ILLINOIS - DETROIT, MICHIGAN


HIGH
ABOVE
ALL
IN
GLOBAL
TRANSPORTATION
THE RAINBOW, HAPPY SYMBOL OF PEACE-TIME AIR SAFETY, WILL EMPHASIZE, AS NO PLANE YET CONCEIVED, THAT THE VAST IMPROVEMENT IN MODERN AIRCRAFT DOES NOT JUST HAPPEN...AND THAT GREAT AIRPLANES SUCH AS THIS NEW LUXURY LINER, ARE BORN OF FAR MORE THAN SHEER CREATIVE GENIUS. FOR ONLY WAR'S TRIED AND TESTED EXPERIENCE WITH HIGH-SPEED FIGHTERS, SUCH AS THE THUNDERBOLTS, WHICH ESTABLISHED RECORDS FROM SEA LEVEL TO STRATOSPHERE, COULD ASSURE THE RUGGED SAFETY, THE RELAXING COMFORT AND THE UNAPPROACHED SPEED OF THIS REVOLUTIONARY TRANSPORT.
REPUBLIC
Rainbow
A PRODUCT OF REPUBLIC AVIATION
Makers of the Mighty Thunderbolt

• • •

TINY GIANT WITH A HISTORY

Long before the war, the men who design your Bell Telephone System were looking for an electron tube with frequency capabilities never before attained. With it, they could transmit wide bands of telephone messages — several hundred of them — simultaneously through coaxial cable—economically, and over long distances.

They developed a tube which set a new standard in broad-band, high-frequency amplification. So minute that its electrode system had to be inspected under a magnifying glass, the tube could amplify either the voices of 480 people talking at the same time, or the patterns of television. Long-distance, broad-band transmission became a commercial reality.

6AK5

Cross-section of Electrode System (five times actual size)

When war came, this tube excelled all others as an amplifier in certain military equipment. It then grew into the 6AK5, one of the great little tubes of the war. Besides producing 6AK5's in large quantities, the Western Electric responded to emergency needs of the Army and Navy by furnishing design specifications and production techniques to other manufacturers, of whom at least five reached quantity production. On every battlefront it helped our ships and planes to bring in radio signals.

Developing electron tubes of revolutionary design has been the steady job of Bell Laboratories scientists ever since they devised the first practical telephone amplifier over thirty years ago. Now tubes like the 6AK5 will help speed the living pictures of television, as well as hundreds of telephone conversations simultaneously over the coaxial and radio highways of the Bell Telephone System.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.

ANNOUNCEMENTS—

of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

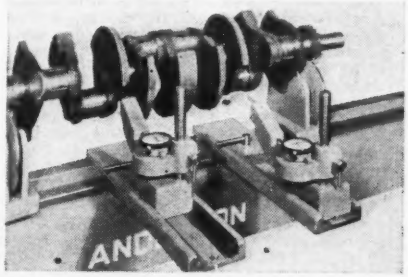
In writing, emphasis upon specific aviation applications of newly-marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—

New Products Editor, AVIATION 330 W. 42d St., New York City 18

"Jotee" and "Joel". Shown left (p. 240) is former, ratchet type torque wrench made of aluminum, preset at factory to any torque between 5 to 40 in./lb. It can be reset by user when specifications change. "Joel" wrench (right) has same range and is made in ratcheting and non-ratcheting types.—AVIATION, Nov., '45.

Crank Shaft Checker.....98

Anderson Bros. Mfg. Co., Rockford, Ill., announces special "Roto-Checker" for checking crank shaft bearings. Shaft is



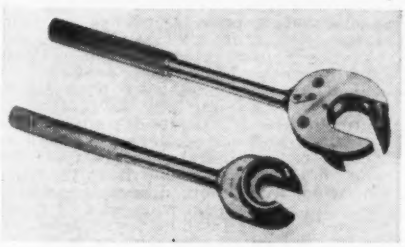
revolved on four rotating disks as a number of indicators are brought into position. Bases are 42 and 64 in. long. Larger units can be made to suit special work.—AVIATION, Nov. '45.

Buffing Tool 99

Developed to put gloss finish on Lockheed P-80, new Model 20 PA buffing tool made by Keller Tool Co., Grand Haven, Mich., has plastic handle, operates by air at 2,300 rpm., is right angle type, uses 7 in. buffing pad, and weighs about 7 lb.—AVIATION, Nov., '45.

Open End Ratchet Wrenches.....100

Designed to speed operation of running and tightening nuts on tubing, cable, or long studs, where ordinary socket or



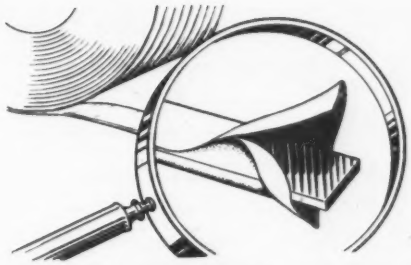
ratchet cannot be used, new open end ratchet wrenches developed by Tubing Appliance Co., Los Angeles, are reversible and have replaceable sockets with range of hex sizes from ⅜ to 2⅛ in.—AVIATION, Nov., '45.

Soft-Faced Hammers 101

New material for "Basa" replaceable face hammers, made by Green, Tweed & Co., New York City, does not chip, is not affected by solvents, and is non-inflammable and non-explosive, it is stated. It is further reported that it does not mushroom, shrink, expand, or contract.—AVIATION, Nov., '45.

Steel Box Strapping.....102

Consisting of a flexible steel core sheathed in waterproofed kraft paper, "Fiber-Steel" is new box strapping made by A. J. Gerrard & Co., Chicago. It is stated strapping can be applied to enam-



eled or painted surfaces without danger of marring.—AVIATION, NOV., '45.

Safety Floor Coverng.....103

Developed as a lightweight slip-proof surfacing, "Ferrox" is made by American Abrasive Metals Co., Irvington, N. J. A synthetic resin containing an abrasive, it may be applied to floor with a trowel or spray gun.—AVIATION, Nov., '45.

Plastic-Foam Insulation 104

Developed by United States Rubber Co., New York City, new plastic foam is buoyant and can be used for insulation for airplanes. Called "Flotofoam" material weighs less than 1½ lb. per cu. ft. and can be made to weigh less than ¾ lb. per cu. ft.—AVIATION, Nov., '45.

Electrical Appliances

Hydraulic Power Package.....105

Comprising an electric gear type fluid pump, visual reservoir, adjustable pres-

New Keyless Chuck

does its own drill tightening

THE TURNER CHUCK Saves Time!

Hardened bearing steel roller jaws grip the drill without chewing or scoring.

Grip is automatically and progressively strengthened with increased load pressure

Ball bearings increase life.

Absolutely KEYLESS. No more chewed drill shanks. No more time wasted looking for keys.

The Turner Chuck is self-energizing. Tightens itself by the action of the drill.

Drill will not slip in use. Chuck is automatically self-centering and drill runs true without hand adjustments.

Sold Exclusively By:

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TURNER BROTHERS

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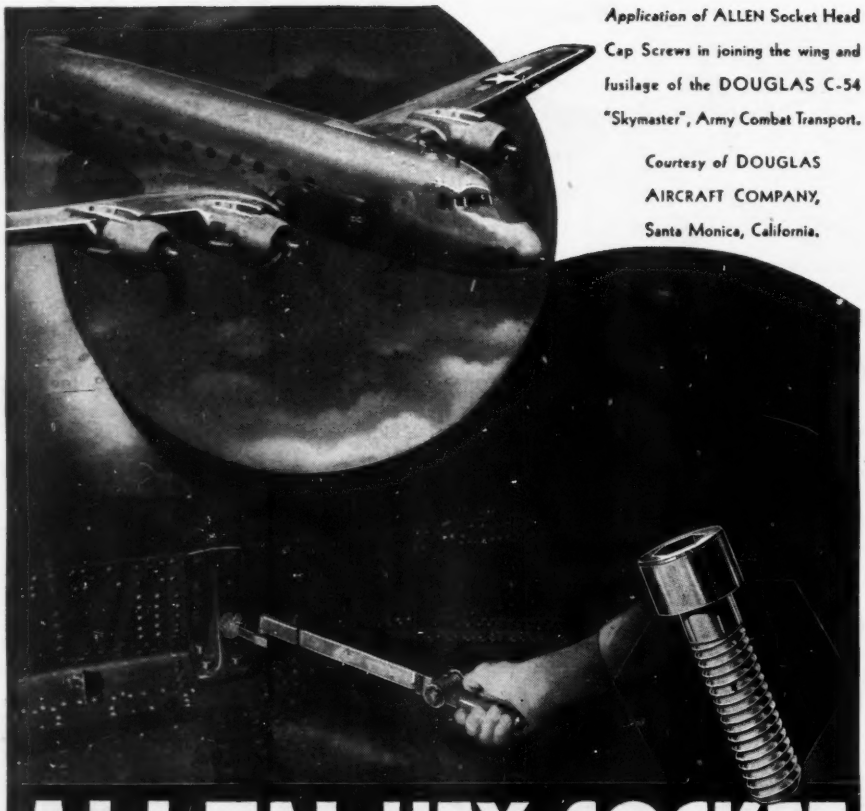


Application of ALLEN Socket Head Cap Screws in joining the wing and fusilage of the DOUGLAS C-54 "Skymaster", Army Combat Transport.

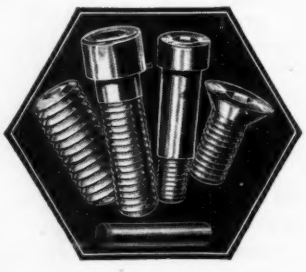
Courtesy of DOUGLAS AIRCRAFT COMPANY, Santa Monica, California.

ALLEN HEX-SOCKET ★SCREWS★

Enormous stresses come to a focus where the wing of a giant aircraft is joined to the fusilage. Here, on a DOUGLAS C-54 "Skymaster", the reinforcing fittings are held by ALLEN Socket Head Cap Screws.

But a relatively small part of Allen's service is in the air — meeting critical strains on planes. *In the plants* that make the planes, "Allens" hold together a multitude of machine and tool assemblies with that never-let-go tenacity dramatized in the air.

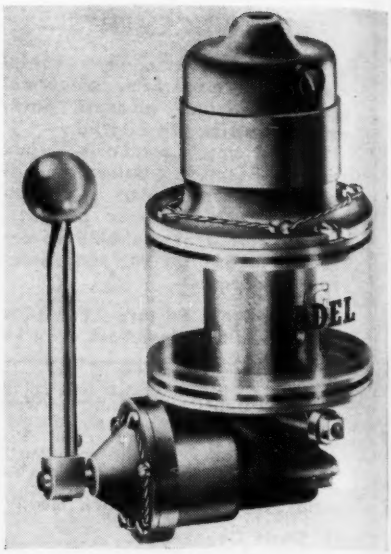
ALLENS have strength for set-ups with weld-like grip, not to be budged by shock-stresses or sustained vibration. Thread tolerances are held to a high Class 3 fit, for a high degree of frictional holding-power...Screws cold-drawn and *"pressurformd"* of special-analysis ALLENOY steel, heat-treated under scientific controls. Hexagon sockets handily reached with Allen Hex Keys in the hardest-to-get-at places. Adapted to high-speed assembling with power drivers.



TRADE A MARK

Allen Hex-socket Screws and "Tru-Ground" Dowel Pins supplied only through Industrial Distributors in all centers.

THE ALLEN MANUFACTURING COMPANY
HARTFORD 1, . . CONNECTICUT, U. S. A.



sure relief valve, thermal relief valve, cylinder by-pass valve, and a four-way selector connected to manual control, new hydraulic power package developed by **Adel Precision Products Corp.**, Burbank, Calif. is a lightweight source of power for actuation of landing gear and wing flaps in small airplanes. Pump delivers fluid under 300 psi. at 0.40 gpm. with power requirement of .298 watts at 12v. Unit measures 4 in. dia. by 9 5/16 in. high, while weight filled is 4.875 lb., and empty 4.50 lb. Four fittings are required to connect. —AVIATION, Nov., '45.

Capacitor-Start Motor.....106

Small Motors, Chicago, announces SM-30 capacitor-start induction motor made in sizes 1/25 to 1/70 hp. and wound for speeds of 3,350, 1,725, and 1,150 rpm. in capacitor and split phase, or 3,100 and 1,550 rpm. as a shaded pole motor. It is stated that it is especially suited to needs of quiet, continuous, or intermittent service. Dia. is 3⅞ in., height with rigid base is 3⅞ in., and length of body is 4⅞ in. plus shaft extension. Capacitor of approximately 2 in. dia. by 4 in. long, may be attached at top, side, or base, or may be mounted separately near motor. Weight is 4½ to 7 lb., depending on rating. Unit is wound for standard voltages up to 460 v.—AVIATION, Nov., '45.

Cold Cabinet.....107

Operating with dry ice and designed to satisfy all cold test conditions required by present day testing techniques, from minus 90 deg. to plus 220 deg. F., "Vari-Temp" cold cabinet is made by **Precision Scientific Co.**, Chicago. Vertical front opening door provides access to chamber large enough to hold apparatus used in making Youngs Modulus test of natural and synthetic elastomers at normal and sub-normal temperatures. Thermometers and instruments in any part of chamber can be read from outside, since there is no glare and no condensation. All temperatures are thermostatically controlled. Box of 1 cu. ft. capacity is 53 in. high, 26 in. wide, and 26 in. deep while 8-ft. box is 73 in. high, 39 in. wide, and 39 in. deep. Center of test chamber, which is 24x24x 24 in., is located at operating height of 48 in. Operation is on 115v., 60 cycles a.c. —AVIATION, Nov., '45.

Capacitor Mounting Brackets.....108

New removable mounting brackets can now be obtained with small rectangular-case capacitors. Made by **General Electric Co.**, Schenectady, N. Y., they are for use in either a.c. or d.c. applications, and can be clamped over either top or bottom flange of case, permitting unit to be mounted in upright or inverted position. —AVIATION, Nov., '45.

New Vertical Motor.....109

New addition to line of **Crocker-Wheeler Div. of Joshua Hendy Iron Works**, Ampere, N. J., is vertical drip-proof motor rated at 40 deg. C. rise continuous duty with 15% service factor, and designed for operation from 60 or 50 cycle, 2 or 3 phase circuits of standard voltages. Ventilating openings are shielded against dripping liquids and falling particles. Unit

has "Alucast" rotor, with bars, fans, and end rings cast in one operation from aluminum alloys, and coils are protected with Vinylastic insulation.—**AVIATION, Nov., '45.**

Selenium Rectifiers 110

Utilizing aluminum in place of iron or other similar metals, **Radio Receptor Co.**, New York City, has developed new line of selenium rectifiers. Units, covering range from 25 mils to capacities of hundreds of amperes, are hermetically sealed. —**AVIATION, Nov., '45.**

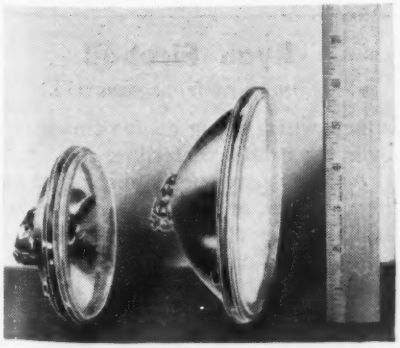
Aircraft Parts & Field Units

Portable Flashing Beacon.....111

Producing high intensity, short duration, intermittent light flashes, lightweight, portable flashing beacon for identification signalling is announced by **Electronic Laboratories,** Indianapolis. Beacon operates from 110v. d.c. or a.c. and has vibrator power supply for converting to 2,000 d.c. to produce flashing light. Connections are water-proof, as is carrying case. Maker states unit weighs less and requires less power than stationary beacons, produces 30,000,000 cp., and under normal conditions is visible at least 20 mi. at night. Beacon can be used by airports in smaller communities which cannot afford stationary type or can be used as stand-by units at larger airports.—**AVIATION, Nov., '45.**

Landing Lamps 112

Two small editions of landing lamps have been developed by **General Electric Lamp Dept.**, Cleveland, for private aircraft. Smaller lamp is designated as No. 4509 and larger as No. 4537. Each is an



Good news for designers, engineers, manufacturers, dealers and users alike. It means you can have — not "just gasoline engines" — but Briggs & Stratton "Air-Cooled Power."

Precision manufacture and constant advancements in design and engineering account for the brilliant record of well over 2-¼ Million of these trouble-free 4-cycle gasoline engines during 26 years of continuous production.

Only by specifying Briggs & Stratton "Air-Cooled Power" can you get all of the advantages which have earned for Briggs & Stratton unquestioned leadership as manufacturers of "the world's finest gasoline engines."

BRIGGS & STRATTON CORP., *Milwaukee 1, Wis., U. S. A.*

Air-Cooled Power

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

BOND CASTERS KEEP PRODUCTION

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EACH BOND CASTER is designed and constructed to meet a particular industrial need . . . and the complete Bond line includes every type caster your materials handling system requires.

When you buy Bonds, there's no need to accept substitutes—or something *almost* as good.

Consult your Bond catalog, or check with your distributor. Then select the *right* casters—the ones engineered for *your* job. They'll keep your production rolling at top speed.

Bond 136-A Caster (top). Combines easy swiveling with long service because of the special arrangement of its double ball races and the use of durable Bond caster metal. Pressure lubricated throughout.

Bond 140-A Caster (second from top). Its sturdy, all-steel construction reduces caster breakage—cracking—or excessive wear even under peak loads. Sizes from 4" to 12", capacities from 450 lbs. to 4000 lbs. per caster.

Bond 1640-A-8 Caster (third from top). Equipped with wheel brake. Same construction as 140-A. 8" size only.

Bond 118-A Caster (bottom). Triple ball race construction for extra hard service and heavy duty. Cupped raceways assure even wear and long life.

FREE—If you do not have a Bond catalog, send for the latest edition (K-36) today.

BOND FOUNDRY & MACHINE COMPANY, MANHEIM, PA.

Bond Reg. U. S. Pat. Off.

TRUCK CASTERS
Built-for-the-Job

all-glass hermetically sealed and self-reflecting unit, with clear cover glass or face. Both units are rated at 100 watts, with small lamp of 4½ in. dia. and producing beam rated at 100,000 cp. and large lamp of 5¾ in. dia. and producing beam rated at 200,000 cp. Cover glass of these units are nearly flat for use in retractable landing light gear.—**AVIATION, Nov., '45.**

Aircraft Battery 113

Released is information on special battery designed for Lockheed P-80 by **Electric Storage Battery Co.**, Philadelphia. Container is of new plastic, with quick-disconnect cable connections built for instantaneous installation and removal. Additional features are electrolyte level limiting device, full aerobatic non-spill design, and self-contained ventilating chamber.—**AVIATION, Nov., '45.**

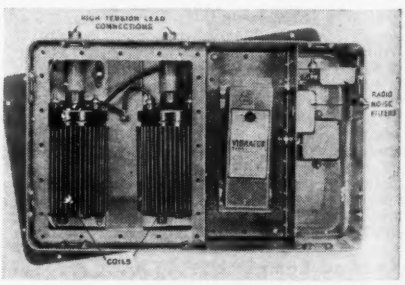
Radio Receiver for Aircraft.....114

Designed as small lightweight radio receiver for private flyers, Model 117 receiver made by **Electronic Specialty Co.**, Los Angeles, is five tube superheterodyne utilizing automatic volume control, co-

axial lead-in, and antenna matching transformer. Battery operated, it measures 3¾ in. cube and weighs 1 lb. 12 oz., with battery pack measuring 2¾x2¾x6½ in. It may be mounted through 3 in. hole.—**AVIATION, Nov., '45.**

Aircraft Heater Ignition.....115

Equipped with new positive ignition coil box assembly (illustrated), Janitrol aircraft heaters can be ignited to burn without fuel preheating from sea level to 63,-



500 ft. at 67 deg. F. below zero, maker, **Surface Combustion Corp.**, Toledo, states. Ignition box and high tension sparkplug leads used with system are radio noise shielded.—**AVIATION, Nov., '45.**

Ryan Fireball

(*Continued from page* 171)

wings, which swing up and almost meet over the craft's centerline.

A newly developed laminar flow section is used, and flush rivets are held to extremely close tolerances since no filler is used on the craft.

Two 1,000-lb. bombs or drop fuel tanks can be carried beneath the wing inboard of the landing gear, and

HVAR rockets may be mounted under the outer panels.

Nose wheel of the landing gear retracts aft and up into the fuselage; main wheels retract outward into wells covered by hydraulically operated fairings. For carrier landings, the arresting hook is hinged under the fuselage just forward of the breaking point, and in retracted position it fits in a slot along the bottom. Having the arrestor hook near the center of the plane is said to make it possible to land much farther off center of the deck without damaging the craft, and the tricycle gear permits flying right onto the deck if necessary.

With a maximum range of 1,500 mi., the FR-1 has a cruising speed of 207 mph. and high speed of 320 mph. on the conventional engine alone, and there is top speed of about 300 on the jet alone. While the Navy has not divulged top speed with both engines operating, the FR-1 is obviously "in the 400-mph.-plus class."

More important than hight straightaway speed, Ryan engineers and Navy officials point out, is the fact that the craft "has the shortest turning radius at comparable speeds of any modern fighter" and that with both engines operating it climbs at better than 5,000 fpm. An unusually high rate of climb can be maintained at all altitudes, it is pointed out, with the reciprocating engine operating at highest efficiencies at lower altitudes, and the jet engine reaching its greatest efficiency at higher altitudes. With both engines operating, the plane can take off with a very short run and immediately go into a steep and continuing climb. Despite the fact that the FR-1 has two separate power plants and has been built to typical Navy strength specifications, Ryan engineers have been able to keep the gross weight to 9,800 lb., much lighter than many types having but a single power plant.

AA Employee Poll

(*Continued from page* 173)

and fin are to be mounted high on the rudder. Planned are two P&W Double Wasp R-2800 hp. engines, each of 2,100 hp. at takeoff.

Gross weight of the craft is given as 36,000 lb., weight empty at 24,600 lb., and payload at 11,400 lb. Cruising speed at 10,000 ft. is estimated as 252 mph. Span would be 96 ft., length 72 ft., height 26 ft., and wing area 738 sq. ft. The airline points out that the craft's features would include truck-level loading, quickly interchangeable engines with small nacelles, and alternate baggage arrangements.

Curtiss-Wright CW-28 is planned as

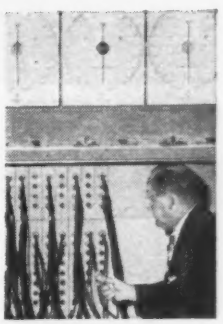
One of the fans in the Cooperative Wind Tunnel-owned by Consolidated Vultee, Douglas, Lockheed and North American—operated by the California Institute of Technology.

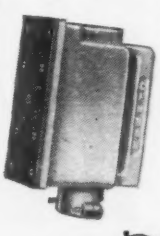
CANNON PLUGS IN ALL CIRCUITS OF THIS NEW WIND TUNNEL

Two fans, each 21 feet 9½ inches in diameter, with a main drive of 12,000 hp. maximum, develop an air speed of over 700 m.p.h. in this new aircraft testing machine. Models are tested under air pressures ranging from one-quarter atmosphere to four atmospheres. Aerodynamic forces and moments are measured accurately, readings automatically recorded.

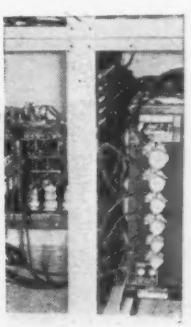
More than a thousand Cannon Connectors are employed in the electric circuits of the installation. Their use makes possible the quick and easy interchange of equipment, eliminates the duplication of costly instruments, increases the accuracy of the records taken.

Cannon Connectors, available in many thousands of standard capacities, sizes and types, may serve well in the circuits of the instruments you use or the products you manufacture. Write for a Condensed Catalog. Cannon Electric Development Co., Dept. A-110, 3209 Humboldt St., Los Angeles 31, California.





Above: Measuring dials recording forces and moments through control panel of Cannon Connectors. *Left:* Special Cannon Connector for portable control and recording unit. *Below:* Cannon Plugs used on measuring and recording machines designed and installed by International Business Machines Corporation.



CANNON ELECTRIC

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Cannon Electric Company, Limited, Toronto

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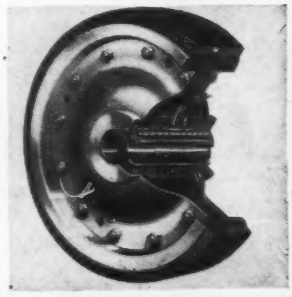
•• Demand DARNELL
CASTERS & E-Z ROLL WHEELS

made in all sizes in both swivel and stationary types

furnished with either semi-steel or rubber tread wheels

A SAVING AT EVERY TURN

assure maximum floor protection and reduce wear on equipment



plus an appreciable increase in employee efficiency

DARNELL CORP. LTD. 60 WALKER ST., NEW YORK 13, N.Y.
LONG BEACH 4, CALIFORNIA 36 N. CLINTON, CHICAGO 6, ILL.

a low-wing monoplane seating 32. It would be powered by two 2,500-hp. Wright R-3350's. Passenger cabin is to be fitted with fluorescent lighting, and an annunciator system would permit each passenger to summon the hostess by means of a push button which would sound a chime and flash a light indicating the passenger making the call. It is stated that special attention has been given to buffet arrangements, with refrigeration units and provisions for maintaining constant high temperatures for entrees and vegetables.

Gross weight is placed at 40,000 lb., weight empty at 27,000 lb., and payload is given as 13,000 lb. Cruising speed would be 288 mph. Span would be 100 ft., length 73 ft., height 27 ft., and wing area 875 sq. ft. Dual nose wheels are to be used. In AA's consideration, the hostess arrangements and buffet constitute the CW-28's noteworthy features.

For the Convair Model 110, the airline details the following features: Low-level floorline, warm-wall heating, dual tricycle wheels, pressure system for underwing refueling, jet exhaust, and integral passenger entrance through the tail. The DC-8 features internally mounted engines, contra-rotating propeller, individual "bug-eye" cockpit canopies, low-level line maintenance, integral steps and doorway through cabin side, and large windows.

Highlights of the Martin 202 are given as thermal anti-icing, large windows, separate passenger and freight entrances, integral system for ground heating and ventilation, belly-mounted radio, and large cargo doors.

This is believed to be the first time an operator has attempted this kind of a poll on such a large scale, and the results gathered are expected to be of great value in the final selection of new equipment. At the same time, the varidepartmental views of the many aviation employees will doubtless prove of interest to the aircraft designers and manufacturers.

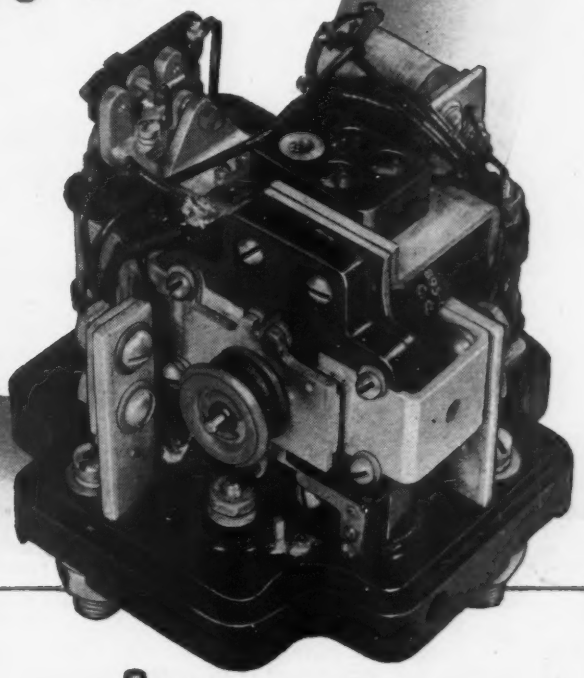
Globe Calculator

(*Continued from page* 193)

(c) Read true course from azimith circle.
(d) For check points along the route, move lens to selected points and read distance.

2. To use as a star finder:
(a) Set zenith lens over position at time of sighting.
(b) Set "midnight" on star-hour-angle scale under the observer's meridian.
(c) Set dates on celestial globe opposite local time on star scale.
(d) The sub-stellar points of all the stars are now reproduced, and the

KEEPS KILOWATTS "on the beam"



A major improvement in the operation of aircraft electrical systems came with the adoption of the differential-voltage type relay, which acts as a one-way gate to permit the flow of power whenever the potential in the generators is higher than that of the batteries or load bus.

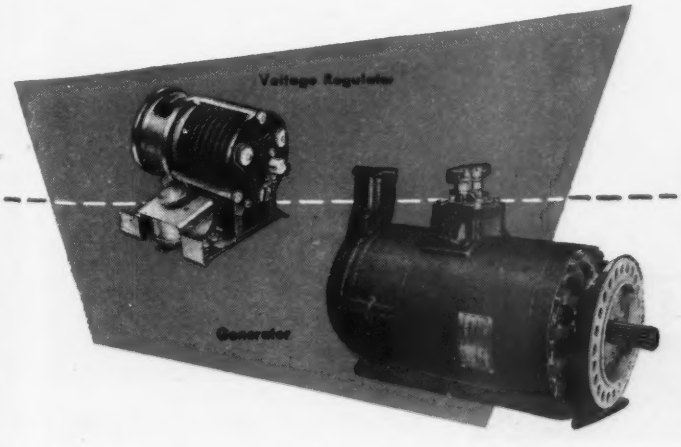
This type of operation frees the relays from dependence on fixed potentials and eliminates the chattering found in common relays, so the contacts last far longer. Now, the generator is never connected to the system under conditions whereby reverse current would tend to drive it as a motor.

Further improvement in operation came with the complete sealing of the differential relay in a case, so that it is unaffected by dust and moisture.

For further information on differential relays, as well as on other Westinghouse aircraft products, write to Westinghouse Electric Corporation, Lima, O

J-03231

The Westinghouse differential relay illustrated, operates with any d-c generator having a normal regulated voltage of 28 volts and a current rating up to 300 amperes.



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AVIATION PRODUCTS

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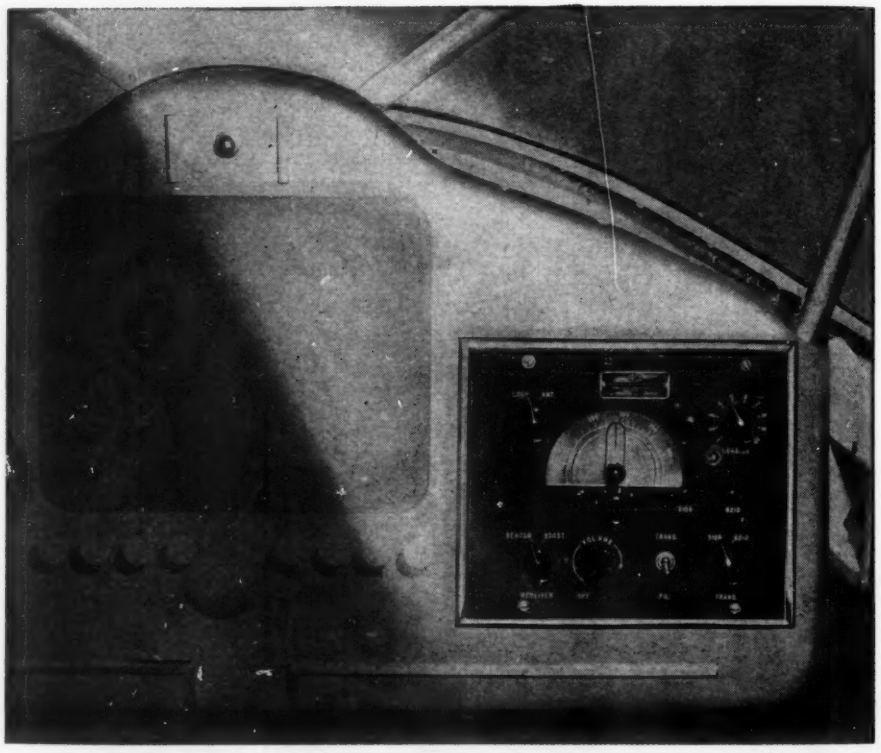
Generator develops 5.7 kw at 28.5 v at 2500/4500 rpm. Weight 44.5 lbs. Has special high-altitude brushes.

Voltage Regulator for 28.5-volt circuits over full range of engine speeds and loads for 50, 100, 200 and 300-ampere generators. Weight: 2.5 lbs.

Pilots depend on Erco



Here is the ERCO FLIGHT MODEL 60 Transmitter-Receiver installed in the Fairchild 24 of Sperry Gyroscope Co.

This custom built equipment is of special design to meet rigid specifications of engineering and symmetry. It marks one of a series of customized FLIGHT MODELS by ERCO.

The illustrated Flight Model dual unit is designed to conserve panel space. All radio frequency circuits are in the panel section. The power supply-modulator is a separate unit which may be installed in the baggage compartment, under seat or any convenient location. Receiver covers both the weather band and broadcast band with ample sensitivity and optimum selectivity. Transmitter operation on two pretuned frequencies, 6210 and 3105 KC, with carrier power of 15 and 20 watts respectively.

Aircraft manufacturers, operators and private owners look to ERCO for satisfaction in flight communications. Completely customized service by ERCO includes Airport Control Towers and all Airport Installations; VHF Receivers and Companion Transmitters; Ground Station equipment and antenna systems. Your requirement is our assignment.

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HEMPSTEAD, NEW YORK

Manufacturers of CUSTOM BUILT RADIO APPARATUS

altitude and azimuth of any specific star can be secured by moving the lens, on the azimuth and altitude are, over the star desired.

3. To secure the time of sunrise and sunset:
   (a) Place your position under the zenith lens.
   (b) Set the sun over date on the ecliptic scale (which is plainly shown on the celestial globe in yellow).
   (c) By setting the sun on the eastern horizon, for time of sunrise, or on the western Horizon for sunset, the time for either may be read on the time scale on the equinoctial under the observer's meridian. The same setting will give the sun's true bearing on the horizon circle.
4. To secure time anywhere on the earth:
   (a) Place your position under the zenith lens.
   (b) Center local time under observer's meridian.
   (c) Time scale on equinoctial will now indicate the time anywhere on earth.

De-Icer Servicing

(*Continued from page* 164)

and gum from pitot or antenna lug hole on both face and back of de-icer, forming a ¼ in. routed area beyond edge of hole. Buff ⅛ in. beyond outer edge of routed area, then wash and cement.

2. Punch or cut out a disk of .080 gum, the size of hole. (Use 4 plys of .020 gum.)

3. Wash and cement a ⅝ in. wide strip of coated reinforcing fabric with stretch lengthwise, then wrap it around .080 gum disk with disk in center of fabric width. Lap ends of fabric ⅛ in.

4. Place fabric and disk in hole in tube so that disk is flush with tube thickness, and fold edges of fabric down on ¼ in. routed area on face and back, then stitch fabric in place and cement entire surface.

5. Cover repair, face and back, with .010 gum. Cover face side with additional gum so that repair is flush with surface. Then cover repair, face and back, with clean holland, cure 15 min. on one side, reverse, cure 10 min. and restore conductive surface.

Air Connection Repairs

To replace ⅝ in. metal connection:

1. Remove washer from around valve stem, then, with knife, cut around connection base ¼ in. from metal stem. Cut carefully through tube fabric and black rubber base of connection and remove metal stem.

2. To remove the remaining part of the black rubber base inside tube, cut through base where it crosses the seaming tape, but do not injure tube fabric, then pry end of base loose so it can be grasped with pliers. Twist around pliers to remove.

3. Buff inside tube equal to the size

OF COURSE C. & S. CALLS ON ROXALIN-ENGINEERED FINISHES TO SPEED THIS IMPORTANT RECONVERSION JOB

Speed is the reconversion order of the day, and Roxalin aeronautical finishes save precious shop time in these hectic days. Take Roxalin's EMYCEL*, the all-weather fabric finish. The humid climate of Memphis where the C. & S. shops are located, demands a fabric finish that won't blush and cause work suspension during damp days. EMYCEL,* was a natural to finish the control surfaces of the Dixieliners. This speed system of fabric finishing cuts finishing time as much as 30%.

EMYCEL* is only one of Roxalin's finishes for aircraft. Any or all of the line listed below is available for important reconversion jobs. Write to Department 155 for complete information.

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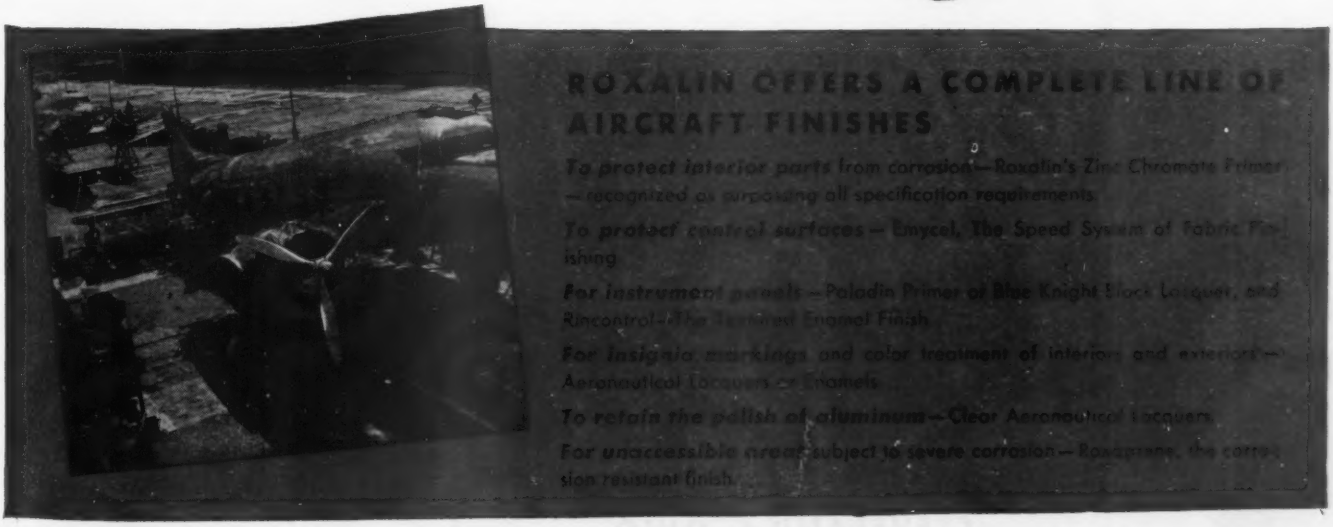
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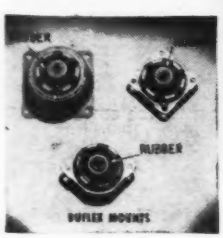
PIONEERING in the highly specialized field of engineered vibration and noise control, the Harris Products Company created and designed the widely used *Torflex Flexible Bearings.*

Torflex Flexible Bearings consist of a tube or ring of rubber stretched longitudinally between two concentric metal sleeves which prevent the rubber from returning to its original state. The pressure exerted by the rubber on the metal sleeves insures a high capacity mechanical bond between the rubber and metal under all operating conditions.

Torflex Flexible Bearings come in a wide range of sizes, consequently they have many applications in various fields. They control and eliminate vibration up to 90 percent, increase performance and efficiency of equipment and greatly prolong its useful life.

If yours is a problem involving vibration and noise drop us a line; our engineers will be glad to work with your engineers in its solution.



HARRIS
PRODUCTS COMPANY
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Branches: 44 Whitehall St., New York • General Motors Bldg., Detroit, Mich.

of new connection base and wash thoroughly.

4. Place holland in tube to protect bottom of tube from cement, then apply two coats of cement to buffed area, allowing each to dry thoroughly. Afterwards, wash base of new connection and cement. When dry, cover top of base with .010 gum, cement again, and allow to dry.

5. Remove holland from tube, dip prepared connection in washing solvent, and force quickly into place through opening. Let washing solvent evaporate before stitching down.

6. Cement around exposed base of connection. Let dry and fill flush to tube surface with gum. Stitch thoroughly to remove air. Cover with 1½ in. o.d. x ¾ in. i.d. uncured washer of lightweight reinforcing fabric.

7. Cement 1½ in. area around base of stem.

8. Cut out 1½ in. o.d. x ¾ in. i.d. washer from .040 cured gum. (Ply and cure .020 gum, or cut from scrap de-icer.) Buff and cement side of washer to be applied to base, then place washer over stem and stitch thoroughly.

9. Work soapstone inside tube under air connection base through air connection and cure 20 min.

To replace rubber slot connections:

1. Remove stem by cutting under flanged base, but do not injure tube fabric. Then buff base area large enough for new slot stem and wash and cement.

2. Apply one layer of .010 gum around buffed area, keeping gum ⅛ in. away from edge of hole to prevent gum from flowing into air connection hole during cure.

3. Buff, wash, and cement base of new stem, place directly over hole, and stitch down firmly, then cover edge of base with a strip of ⅛ in. wide .010 gum to round off edge, and cure 15 min.

To replace hinge tie-in strip:

1. Cut under edge of air connection flap where it joins tube surface to expose hinge, then remove old hinge and buff an area large enough on flap and bottom of tube to replace hinge.

2. Wash buffed area, cement, and dry.

3. Cut a strip of coated reinforcing fabric ⅝ in. wide with stretch lengthwise to form new hinge. Wash and cement, then fold fabric in middle to form hinge.

4. Cut a piece of .010 cured gum to cover lower inside half of hinge, wash and cement one side of gum and lower inside half of hinge. Then position the cured gum piece and stitch thoroughly.

5. Wash and cement hinge. Place hinge in position and stitch firmly from top of flap.

6. Buff area of flap and tube which have been separated. Cement and place .010 gum on entire tube area

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Holley Carburetors are standard equipment on most of the famous Flying Clippers. Holley engineers work in close cooperation with those of Pan American to make safer nearly 6,000,000 miles of flight every month . . . to make the mammoth engines perform smoother and with maximum dependability. Serving Pan American's "Wings Over the World". . . high above millions of miles of measureless ocean . . . is a great tribute to the outstanding dependability of Holley Carburetors.

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from which flap has been lifted. Replace flap on tube, stitch all of repair, and cure 20 min.

Bead Repairs

Torn fabric between bead wire and inside edge of bead.

When tear is partially through bead:

1. Buff area with carborundum stick and cement.
2. Fill tear with gum, stitch and cure 10 min.

When tear is entirely through bead:

1. Buff area with carborundum stick and cement.
2. Fill hole or tear with gum and stitch.
3. Cut two patches of lightweight reinforcing fabric to extend ¼ in. on all sides of tear.
4. Wash and cement patches and position on front and back of bead. Stitch down and cure 20 min.

If fabric on or over bead wire area is torn:

1. Buff area around tear allowing ¼ in. clearance on face and back and cement.
2. Pack tear flush with gum.
3. Wash and cement one patch of light reinforcing fabric that will cover buffed area and wrap it around bead wire.
4. Fit patch to prepared area and stitch thoroughly, then cure 20 min.

Broken bead wire:

1. Cut through buffer strip at point opposite broken wire and lay strip back 3 in. each side of break.
2. With sharp pointed scissors or knife, split top layer of bead fabric in center of channel covered by buffer strip.
3. With knife, separate top ply from lower ply of bead fabric until bead wire is exposed.
4. Straighten ends and buff wire until broken ends of wire can be snugly inserted into metal bead clip. Place brazed side of clip down.
5. Place flat piece of metal underclip, then dent clip with small prick punch two places at each end but not in center where broken ends meet.
6. Wash bead fabric which has been separated and cement.
7. Place a strip of .010 gum covering surface of lower exposed bead fabric.
8. Stitch upper bead fabric into place.
9. Cement buffer strip and channel.
10. Lay strip of ⅛ in. .010 gum over and cure 15 min.
11. Stitch raised buffer strip into place cut in fabric.

To slip fabric on bead wire:

1. Fasten end of bead wire in vise.
2. Tape jaws of common slip-joint pliers and place over bead near vise so bead wire will be in open space behind clamping surface of jaws.
3. Using both hands, clamp jaws on fabric just under the wire and jerk back. This will loosen fabric and cause

New Protector & Depth Gauge

Ends Drill Breakage!

...gauges depth of hole, speeds drilling, saves time

...dimples drive drill close to point where work is being done

NOW YOU CAN drill faster – *and not worry about breakage!* The new Hartwell split-shank drill protector & depth gauge protects your drill at the weakest point. And it lets you set your drill for any desired depth.

The Hartwell drill protector & depth gauge is available in selected sizes from 1/16 through "F." Sizes 1/16 through 10 are held to ¼" outside diameter to fit standard drill chucks. Larger sizes are held to ⅜".

Hartwell also manufactures extension chucks in the above range of sizes, together with rod lengths of 6" and 11".

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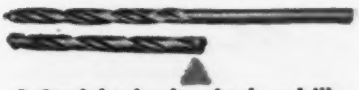
1. Dimples drive drill. Two dimples, set at 180° in the nose, drive the drill. They fit the drill flutes, placing the driving power near the point of the drill.

2. Gauge controls depth. Any desired drilling depth can be set by protector & depth gauge, thereby speeding drilling. Rounded nose protects drilled surface.

3. Split shank. The shank of the protector & depth gauge is split to permit the chuck to lock the drill at any desired depth setting.



4. Straight shank or broken drills. Either straight shank or broken drills, without shanks, can be used in the protector & depth gauge.

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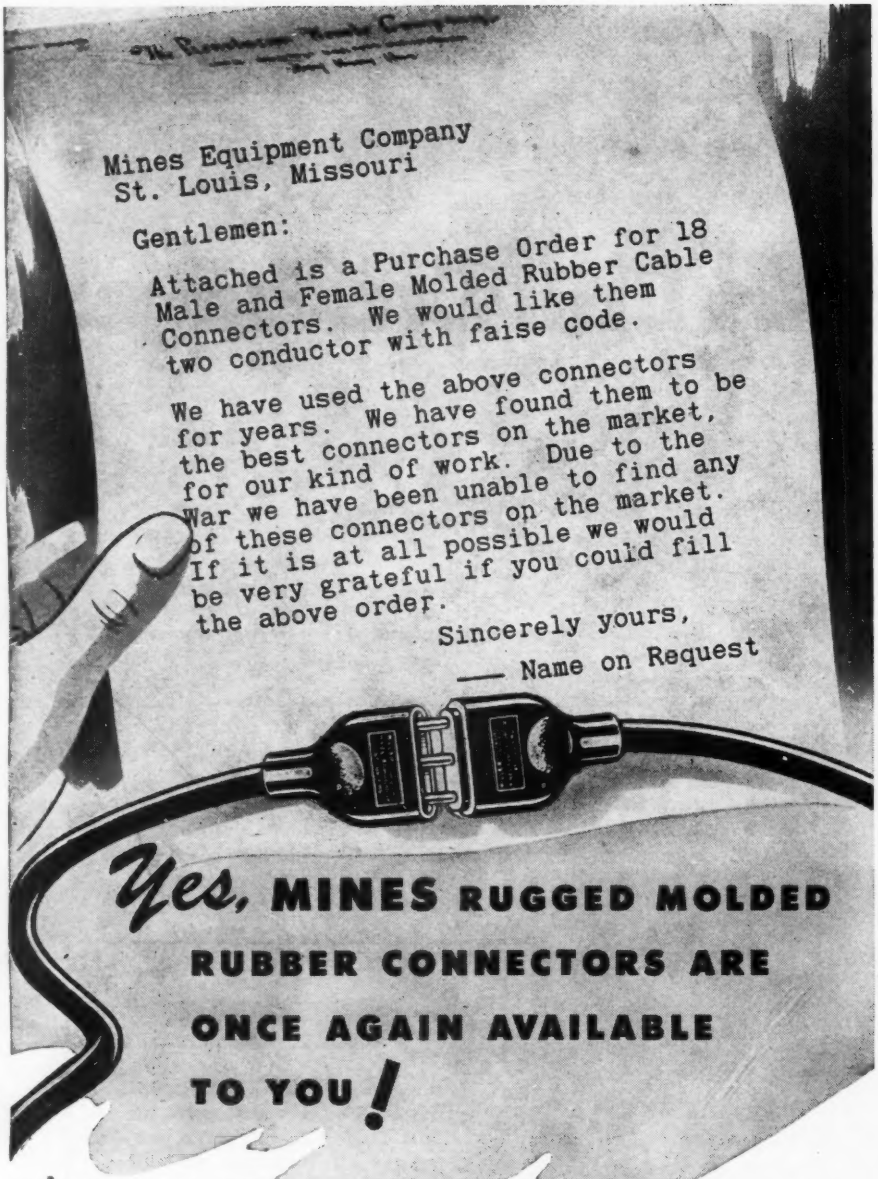
Mines Equipment Company
St. Louis, Missouri
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We have used the above connectors for years. We have found them to be the best connectors on the market, for our kind of work. Due to the War we have been unable to find any of these connectors on the market. If it is at all possible we would be very grateful if you could fill the above order.
Sincerely yours,
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Yes, MINES RUGGED MOLDED RUBBER CONNECTORS ARE ONCE AGAIN AVAILABLE TO YOU!

Now that military demands no longer completely tax our production facilities, we are able once again to supply Mines Molded Rubber Cable Connectors to all industry.

Mines Connectors when molded to electric cable become a part of the cable itself, giving a safe, efficient, water sealed connection. Mines Connectors can be furnished for splicing to cable in your own plant or molded to specified cable lengths.

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For efficient, safe, flexible electric power transmission by cable, use Mines Connectors—"The Connector With The Water Seal."

WRITE FOR BULLETIN MC-106, showing many successful applications of Mines Connectors throughout industry.

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it to wrinkle on wire ahead of plier jaws.

4. Place plier jaws over wrinkles formed in bead fabric and jerk again. Continue this procedure until fabric is loose from wire.

End-Reinforcement Repairs

Repairing a hole or tear:

1. Rout gum off back of de-icer to coated reinforcing fabric. Allow ½ in. clearance around damage. Cement and allow to dry, then cover routed area with .010 gum.

2. Cut a piece of cured reinforcing fabric to fit in routed area. (Stretch in fabric must be at right angles to bead.) Buff side of fabric that will contact routed area. Cement and allow to dry. Lay fabric in place and stitch firmly, then place gum around edge of fabric to round off edge.

3a. With face of de-icer up, proceed as follows *if tear is small:* Rout V-trough along tear or bevel edges of hole. Buff ⅛ in. beyond, then cement trough or beveled edges and fill flush with gum.

3b. *If large hole:* Cut a piece of stretch area from scrap de-icer to fit hole. Rout V-trough along butted edges. Buff ⅛ in. beyond, then cement trough and fill with gum.

4. Cure 10 min., each side, and restore conductive surface.

If tear is along bead:

1. Loosen buffer strip 2 in. beyond tear and rout coated reinforcing fabric from bead notch, ½ in. beyond end of tear.

2. Rout rubber down to fabric on other side of tear, allowing ½ in. clearance, then wash and cement.

3. Cover routed areas with .010 gum and cement.

4. Cut a piece of cured coated reinforcing fabric to fit, then buff and cement side of fabric to be applied.

5. Fill in with gum around fabric to round off edges.

6. On face side, rout a V-trough in tear. Buff ⅛ in. beyond, wash and cement, then pack flush to de-icer surface with gum.

7. Cure 10 min. on each side and restore conductive surface.

Snubber Repairs

Tears in fabric:

1. Wash and buff an area ½ in. wide on all sides of tear and cement.

2. Wash and cement a piece of uncured reinforcing fabric that will cover buffed area. In this case, fabric stretch must be in same direction as bead.

3. Position fabric and stitch firmly in position.

4. Cement edges of tear on opposite side and fill tear flush with gum, then cure 15 min.

Repairing broken de-icer bead wire:

1. Separate snubber fabric at edges of lap. Cut back until snubber wire is exposed, then remove broken wire.
2. Wash exposed wire bed and separated surfaces of snubber fabric and roughen thoroughly surface of areas.
3. Cement new snubber wire and fabric areas which contact wire, with 50-50 mixture of air-cure cements.
4. Cement separated surfaces of lap, lay new wire into position, re-lay fabric, and stitch thoroughly.
5. Cure entire length by spot curing. Allow 5 min. for each spot cure.

Boeing Stratocruiser

(*Continued from page* 177)

controls permits any two of the Stratocruiser's engines to be run up to full throttle with surfaces locked, thus permitting safe taxiing and engine run-ups in high winds. Takeoff with surfaces locked is impossible. Nor can the surfaces be locked in flight. The elevator controls are duplicated in all elements.

Direct operating costs have been figured at 1¢ per passenger-mile (200-lb. payload unit) at a 300-mi. range, 8¢ at ranges between 1,000 and 1,900 mi., and 1.1¢ per mile at 2,500-mi. range, in contrast to equipment now in service which costs 1.8 to 2½¢ per passenger-mile.

In other terms, the Stratocruiser will carry a payload of 30,000 lb. 500 mi. on 2,110 gal. of fuel; a payload of 19,200 lb. 2,500 mi. on 5,450 gal.; and 11,650 lb. 4,200 mi. on 8,225 gal. Included in each case is an 850-gal reserve.

Extra care has been taken to reduce ground time by providing for quick and easy handling of passengers and cargo, neither interfering with the other, and for ease of maintenance. Some of these features are a door on both the upper and lower deck for passenger use, a separate door for galley supplies, truck-bed-height cargo doors on the lower deck, an electric hoist and overhead rail for cargo movement to or from the upper deck, grouping of accessories for easy inspection and repair, and completely interchangeable power plants.

Review of Patents

(*Continued from page* 204)

changes in position, and resulting angular displacement of mast with respect to plane of rotation of inertia means is used to feather blades to cause rotor to remain uninclined or to tip in opposite direction to mast, thus causing restoring couple.—2,384,516, filed Nov. 10, '41, pat. Sept. 11, '45, A. M. Young, assignor to Bell Aircraft Corp.

Aircraft Design is intended to permit craft to take off vertically, and at sufficient height to be maneuverable into inclined position, and thus proceed, without loss of control in part as helicopter and in part as airplane, in generally horizontal direction at moderate speed. Craft is finally maneuverable into more greatly inclined

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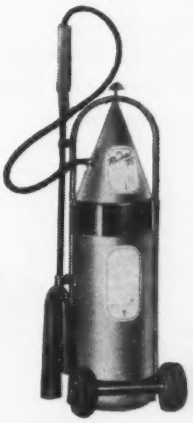

A dry, non-toxic gas, carbon dioxide cannot damage equipment or conduct electricity. It leaves no stain or liquid—no shut-down from water damage.

See, by actual demonstration, how fast-action Randolph "2", "4", "15" or "25" can mobilize and simplify *your* fire defense. For fire protection guidance and prompt delivery of equipment, call your nearest supplier, or write—

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✱ NEITHER AFFECT NORGREN INDUSTRIAL HOSE ASSEMBLIES

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Fitted with machined brass couplings—permanent for high pressures, reusable for low pressures. Will not leak up to bursting point of hose. Stays put under extreme vibration.

Everywhere you need dependable power carriers to keep pneumatic and hydraulic operated machinery working at top speed—that's the place for Norgren Hose Assemblies!

Recommended for operating temperatures of —40° F. to 250° F. Flex almost indefinitely without failure. Won't kink on sharp bends. Available 1/4" to 1" I. D., any length. Write for catalog 450. C. A. Norgren Company, 220 Santa Fe Drive, Denver 9, Colorado.

Norgren

position until main axis is horizontal and craft is flying at high speed as an airplane with thrust supplied by what were lifting propellers and lift supplied by wing.—2,382,460, filed Jan. 8, '41, pat. Aug. 14, '45, A. M. Young, assignor to Bell Aircraft Corp.

Method of Skin Blanket Attachment contemplates series of channel members serving to support skin sheet and having inwardly extending flanges or face portions. Channel members and their flanges run spanwise of skin sheet, and adapted to be disposed and secured between adjacent flanges of two adjacent channel members is tubular strengthening stringer. For attachment of skin blanket assembly to rib structure, attaching clips are provided, adapted to be attached to inwardly extending flanges and extend into face-to-face engagement with a side face or cap-strip of rib assembly.—2,382,950, filed Sept. 14, '42, pat. Aug. 14, '45, M. Watter, assignor to Edward G. Budd Mfg. Co.

Control Mechanism, intended to provide aileron droop without loss of aileron control at time of landing and takeoff, has automatic means selectively responsive only to movement of lower flap of split flap installation, but ineffective when flaps are split. Toggle link arrangement, between divided links adapted for respective connection to ailerons, is connected to the flaps so that when lower flap is lowered by usual flap-operating mechanism, movement will be automatically imparted to toggle links and thence to connecting links to droop the ailerons.—2,376,871, filed May 19, '43, pat. May 22, '45, M. Le R. Stoner, assignor to Curtiss-Wright Corp.

Aircraft Power Plant System includes plurality of prime movers, one or more of which may be disconnected from propulsive unit and maintained in condition for quick supply of power. When one engine is operated, idle engine may be disconnected from power shaft by automatic clutch but continues to receive hot gas from exhaust to keep it warm, so that idle engine may be connected at any instant for furnishing full power.—2,382,343, filed Jan. 9, '42, pat. Aug. 14, '45, E. A. Stalker, assignor to The Dow Chemical Co.

Recent Books

(*Continued from page* 204)

plete breakdown of the new Civil Air Regulations is given in question and answer form. Appendix specifies the flight maneuvers required of the private pilot under the new regulations.

HANDBOOK OF NONFERROUS METALLURGY, Donald M. Liddell, Editor-in-Chief. McGraw-Hill Book Co., New York City. 656 pages, photos, charts, graphs, index. $6.50.

This second edition is the first part of a two-volume handbook giving principles, methods, and data for the practicing metallurgist. It contains a comprehensive treatment of those operations, and of the apparatus and methods fundamental to the branches of nonferrous metallurgy.

A. S. T. M. STANDARDS ON PLASTICS. American Society for Testing Materials, Philadelphia. 542 pages, index. $2.75.

Sponsored by Committee D-20 on Plastics, this compilation dated May, 1945, gives 109 test methods, plus specifications, recommended practices, and definitions covering a wide range of plastics and related materials.

UNDERSTANDING LABOR, by Bernard H. Fitzpatrick. McGraw-Hill Book Co., New York City. 179 pages, appendix. $2.

An analysis of labor phenomena in the work-a-day world for those who would understand the meaning of various contradictory forces in the realm of labor.

THE VELOCITY-TRIANGLE COMPUTER IN PRINCIPLE AND PRACTICE, by S. A. Walling and J. C. Hill. Cambridge University Press, The Macmillan Co., New York City. 36 pages and computer. $2.

This handbook together with mechanical computer pertain to the quick solution of avigation problems for purposes of training the pilot-avigator in his approach to regular service computers. Presented are various problems which are solved by use of the included computer.